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ORIGINAL ARTICLE

Temporal Evaluation of Coronary Revascularization Procedures Performed through the Unified Health System (SUS) in Brazil: a 20-year overview

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Abstract

Introduction: The mortality rates associated with coronary atherosclerotic disease (CAD) have been declining over the past decades driven, in part, by advances in revascularization techniques.

Objective: The aim of this study was to provide an overview of the past 20 years in the treatment of CAD delivered by the Brazilian Unified Health Care System (SUS).

Methods: The data were obtained from SUS's TABNET and SIGTAP systems and IBGE. The procedures were grouped into the categories percutaneous, surgical, and primary percutaneous revascularizations. The analysis included the number of hospital admission authorizations (AIH), mean length of hospital stay, in-hospital mortality, mean total amount paid by procedure, and mean values paid per AIH and for professional and hospital services.

Results: Between 1995 and 2015, there were increases in the number of surgical revascularizations (from 13,198 to 22,559) and percutaneous revascularizations (from 10,522 to 66,345). Similarly, the number of primary angioplasties increased between 2004 and 2015 (from 1,901 to 8,524). There was a decrease in the mean length of hospital stay (from 14.4 to 12.8 days) and hospital mortality (from 7.6% to 5.9%) for surgical revascularizations, and decrease in mean length of hospital stay (from 5.3 days to 3.7 days) but maintenance of the mortality rates (2.2%) for percutaneous revascularizations. In primary angioplasties, the mean length of hospital stay varied from 5.3 to 5.6 days and the mortality rate varied from 7.94% to 7.43% between 2004 and 2015, respectively. The mean total amount paid for surgical revascularization varied from R$ 4,327.57 to $12,839.13 and for percutaneous revascularizations from R$ 2,615.81 to $6,187.87 between 1995 and 2015, respectively. Corresponding values for primary angioplasties were R$ 5,415.58 in 2004 to R$ 6,581.51 in 2015.

Conclusions: The number of revascularization procedures increased in Brazil over the past 20 years, with an improvement in mortality rates and decrease in length of hospital stay. There was a substantial lag in economic values relative to the inflation accumulated during the period. (Int J Cardiovasc Sci. 2017;30(5):380-390)

Keywords: Myocardial Revascularization; Coronary Artery Diseases; Health Care Costs; Angioplasty, Balloon, Coronary; Unified Health System.

Introduction

Cardiovascular diseases (CVDs) are the main cause of mortality and disability in Brazil and worldwide.[1] In developing countries, there is a trend of increased mortality and morbidity associated with these diseases, making them an important public health care problem, with imposition of high costs associated with medical care. The World Health Organization (WHO) estimates that CVDs account for 17.3 million deaths/year worldwide and projects yearly death rates above 23.6 million for 2030.[2]

Coronary artery diseases (CADs) and, consequently, acute coronary syndromes (ACSs) are the main causes of death and hospitalization due to CVDs. ACSs represent one of the most important causes of care and admissions

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to emergency departments in Brazil.[3] The growing number of cases of acute myocardial infarction (AMI), particularly in developing countries, is one of the most relevant public health care issues today.

According to the literature, the in-hospital mortality rates associated with CAD range between 3 and 20%, depending on the patient's status at admission, age, gender, and quality of care received. As a result of advances in ACS treatment, the mortality associated with acute AMI cases has dropped from 30% in the 1950s to less than 5%, as recently recorded in developed countries. This is due in large part to developments observed in the cardiology field with regard to percutaneous and surgical myocardial revascularization techniques.[4]

According to American epidemiological data, more than 1 million individuals present AMI episodes annually, with about 370 thousand deaths attributed to CAD.[2] In Brazil, 31% of the deaths with a confirmed cause are related to ACS.[5] CAD is also responsible for increased costs related to hospitalization in Brazil, with a significant impact on the budget of health care funding agencies, related to costs with medications, prolonged hospitalizations, and high complexity care.[6]

Based on these considerations, the aim of this study is to provide an overview of CAD treatment through an analysis of revascularization procedures performed through the Unified Health System (SUS) in Brazil, evaluating the results of percutaneous coronary intervention procedures and surgical revascularization procedures between 1995 to 2015, including their clinical outcomes and financial management, so as to provide a 20-year overview of the progression of these treatment modalities among us.

Methods

The epidemiological information related to hospital morbidity and mortality, as well as health indicators for the period between January 1995 to December 2015 were retrieved from the TABNET database of SUS's Hospital Information System / Ministry of Health (http://tabnet.datasus.gov.br).[7] Data related to the Brazilian population, estimated or gathered by censuses, were obtained from information provided by the Brazilian Institute of Geography and Statistics (IBGE; http://www.ibge.gov.br)[8] for the population residing in Brazil per geographic region during the study period. The cumulative inflation for the analyzed period was measured by IBGE's National Consumer Price Index (IPCA).[9,10] The data related to orthoses and prostheses were obtained from SUS's System of Management of the Table of Procedures, Medications, and Orthoses, Prosthetics and Special Materials (SIGTAP; http://sigtap.datasus.gov.br).[11]

The procedures were grouped into three analytical categories, according to the interested result: 1 - percutaneous revascularization (32023014 coronary angioplasty, 32035012 double coronary angioplasty with intraluminal stent implantation, 48030066 coronary angioplasty, 48030074 coronary angioplasty with implantation of intraluminal stent, 48030082 coronary angioplasty with double intraluminal stent implantation), 2 - surgical revascularization (32011016 myocardial revascularization with cardiopulmonary bypass, 32038011 myocardial revascularization without cardiopulmonary bypass, 32039018 myocardial revascularization with cardiopulmonary bypass with two or more grafts, 32040016 myocardial revascularization without cardiopulmonary bypass with two or more grafts), and 3 - primary percutaneous revascularization (48030112 primary coronary angioplasty). The analysis excluded valvular procedures associated with surgical revascularization due to specific characteristics of this group. Analytical categories were specified for each of the three groups: number of paid authorizations for hospital admission (AIH), mean length of hospital stay (in days), mortality rate, mean AIH value, mean amount paid for professional services, mean amount paid for hospital services, and total amount paid by the SUS.

The variables are expressed as mean or total values, as provided by the TABNET system. The programs Microsoft Excel 2010 (Microsoft Corporation, Redmond, USA) and Statview 5.0 (SAS Institute, Cary, USA) were used for the calculations and preparation of the graphs.

Results

The results of the categories of the described procedures were grouped by region and processing year. The total number of hospital admissions (according to paid AIHs) are shown in the charts in Figure 1.

Table 1 shows the mean length of hospital stay (in days) and Table 2 presents the mean mortality rates for surgical revascularizations, both stratified by geographic region and year of processing. The same data regarding percutaneous revascularizations are presented in Tables 3 and 4, respectively, while those related to the primary percutaneous revascularizations are shown in Tables 5 and 6, respectively.

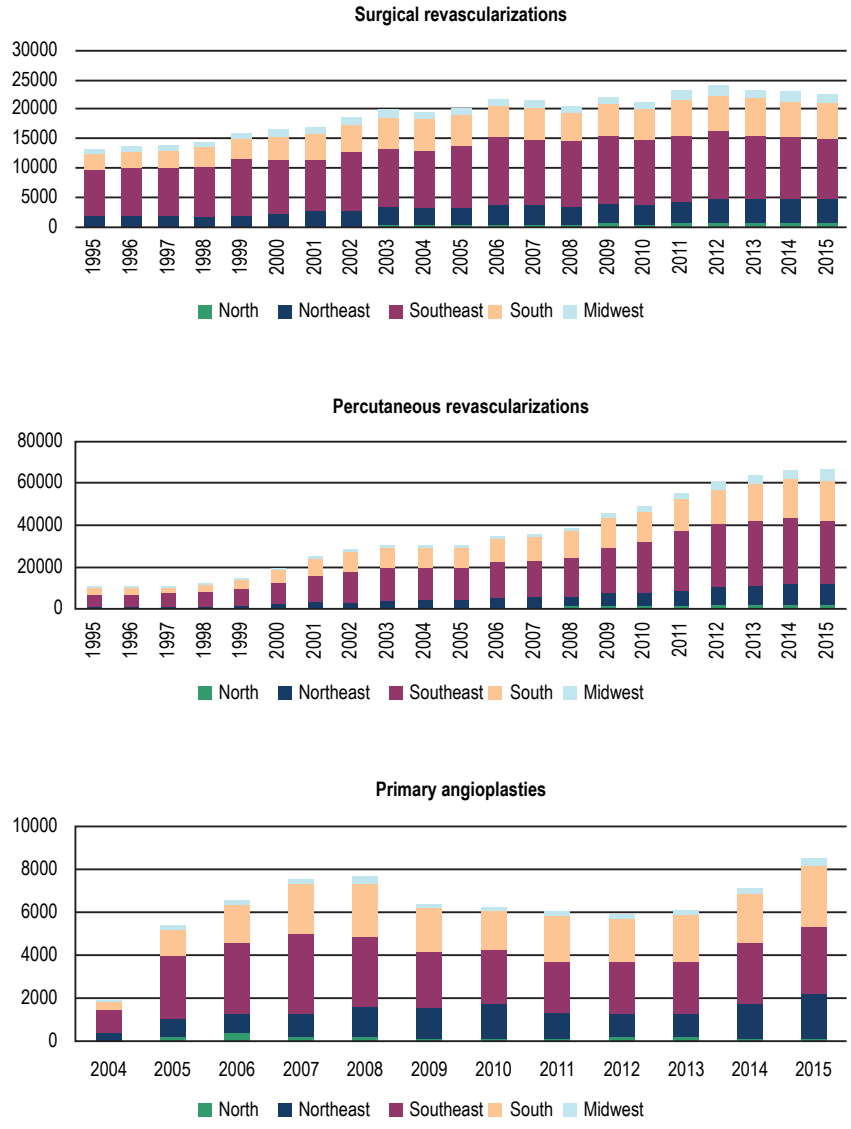

Figure 1 – *Total number of admissions (AIHs) paid according to procedure, by year and region.*

The data comparing changes in the total number of procedures and mean and total amounts paid for the two major groups of procedures (surgical and percutaneous revascularizations, excluding primary angioplasties) are shown in Figure 2.

Regarding the total number of procedures performed annually, the number of surgical revascularizations increased from 13,198 in 1995 to 22,559 in 2015, reflecting a 70.93% increase, and the number of percutaneous procedures increased from 10,522 in 1995 to 66,345 in 2015, reflecting a 530.53% increase. The mean number of procedures in both categories were closest in the year 2000 when the mean number of percutaneous revascularizations reached close to 20 thousand. Similarly, the mean total amounts paid for each procedure were closest in 2001, with the percutaneous revascularization group surpassing the mark of 100 million reais.

As for primary angioplasties, the data were only available from 2004 onwards. Across the period of 10 years, the total number of primary angioplasties per year increased from 1,901 in 2004 to 8,524 performed in 2015, a 348.39% increase.

An analysis evaluating the performed procedures according to geographic region observed that the total number of procedures was highest in the Southeast,

Table 1 – Mean length of hospital stay (in days) by geographic region and year of processing for surgical revascularization procedures

Region	N	NE	SE	S	M	Mean
1995	21.4	12.3	15.4	13.0	14.3	14.4
1996	20.6	12.3	15.8	12.6	14.8	14.6
1997	19.4	11.8	15.4	13.0	13.8	14.4
1998	20.8	11.4	15.5	13.0	14.8	14.4
1999	15.3	11.6	14.6	12.6	14.7	13.8
2000	13.4	10.6	13.6	12.2	14.1	13.0
2001	14.4	10.9	13.3	12.5	13.9	12.8
2002	15.8	11.7	12.8	12.7	14.5	12.8
2003	15.5	10.9	12.6	12.6	13.3	12.4
2004	16.1	10.7	12.9	13.3	12.6	12.7
2005	15.8	10.2	12.3	11.9	11.7	11.9
2006	15.3	10.2	12.4	11.9	10.8	11.9
2007	14.5	10.3	12.3	11.7	12.2	11.9
2008	14.9	10.4	12.3	11.4	11.8	11.8
2009	16.8	10.2	13.1	12.3	11.7	12.5
2010	15.2	10.2	13.4	12.5	11.9	12.7
2011	15.7	10.2	13.6	12.6	12.2	12.8
2012	16.3	10.0	13.6	12.8	12.7	12.8
2013	17.7	10.4	13.4	12.6	12.7	12.7
2014	14.7	10.4	13.5	13.4	13.8	13
2015	15.5	10.5	13.2	13.3	12.9	12.8

Abbreviations: N: Northern region; NE: Northeastern region; SE: Southeastern region; S: Southern region; M: Midwest region.

followed by the South region. The proportions of procedures according to geographic region showed no significant variation over the period for any of the evaluated procedures. An individual analysis of each region is beyond the scope of this article.

In regards to hospital outcomes, the mean length of hospital stay for surgical revascularizations decreased from 14.4 days to 12.8 days, which was accompanied by a decrease in the in-hospital mortality from 7.6% to 5.9%. As for the mean duration of hospital stay for percutaneous revascularization, the mean length decreased from 5.3 days to 3.7 days, while the mortality rate remained constant at 2.2% across the evaluated period. For primary angioplasties, the mean duration of hospital stay remained relatively constant, with a small increase from 5.3 days to 5.6 days, while the mortality rate showed a slight decrease from 7.94% to 7.43%. There was a significant variation among the evaluated regions in regards to hospital-related outcomes.

Regarding the amount paid per surgical revascularization procedures during the study period, the mean amount paid to hospitals varied from R$ 4,327.57 in 1995 to R$ 12,839.13 in 2015 (a 196.68% increase), while the mean amount paid to health care professionals varied from R$ 562.82 in 1995 to R$ 4,766,31 in 2015 (a 746.86% increase). As for percutaneous revascularization, the mean

Table 2 – Mean mortality rates (in percentage) by geographic region and year of processing for surgical revascularization procedures

Region	N	NE	SE	S	M	Mean
1995	22.2	5.9	7.7	7.3	10.4	7.6
1996	11.4	7.5	7.6	6.7	9.5	7.5
1997	16.3	6.9	7.7	7.4	8.8	7.7
1998	7.3	5.7	6.5	6.2	8.2	6.4
1999	5.3	7.0	6.3	6.0	9.3	6.5
2000	9.6	6.7	6.2	7.4	11.2	7.0
2001	10.5	7.5	6.5	7.2	10.1	7.2
2002	7.0	5.9	7.0	6.5	9.4	6.9
2003	8.1	5.3	6.3	6.1	9.7	6.4
2004	11.1	6.0	6.5	7.3	10.2	7.0
2005	7.4	5.2	6.0	6.7	7.8	6.2
2006	7.3	5.1	6.0	6.5	8.8	6.2
2007	7.3	5.1	6.2	6.5	9.5	6.3
2008	10.0	5.5	5.7	7.2	9.4	6.3
2009	7.3	5.6	5.1	5.6	8.5	5.6
2010	8.3	4.8	5.1	6.0	7.2	5.5
2011	9.8	5.4	5.0	5.8	6.2	5.5
2012	7.8	4.5	5.0	6.1	6.9	5.4
2013	10.5	5.6	5.4	6.0	9.4	6.0
2014	7.5	4.9	5.3	6.1	7.3	5.7
2015	8.2	5.4	5.3	6.3	8.1	5.9

Abbreviations: N: Northern region; NE: Northeastern region; SE: Southeastern region; S: Southern region; M: Midwest region.

amount paid to hospitals varied from R$ 2,615.81 in 1995 to R$ 6,187.87 in 2015 (a 136.55% increase), while the amount paid for professional services varied from R$ 293.94 in 1995 to R$ 777.00 in 2015 (a 164.34% increase).

Discussion

The data found in this study allow for an evaluation across a large time frame in the context of the treatment of coronary disease through the SUS in Brazil. These data reflect the progression of the treatment of these diseases in the largest part of the Brazilian population, since the public network covers more than 70% of the population in the country, according to data from the Brazilian Ministry of Health.[7]

At the beginning of 1995, the amount paid for professional services accounted for 13% of the total amount paid for surgical revascularization and 11.23% of the total amount paid for percutaneous revascularization. In 2015, these values represented 37.12% and 12.56%, respectively. In regards to primary angioplasty, the mean total amount paid to hospitals has remained constant over the past 10 years, from R$ 5,415.58 in 2004 to R$ 6,581.51 in 2015 (a 21.55% increase), while the mean amount paid for professional services ranged from $449.41 to $961.87 (an 114.03% increase), representing during this period 8.30% and 14.61%, respectively, of the mean total amount paid for primary angioplasty procedures.

Table 3 – Mean length of hospital stay (in days) by geographic region and year of processing for percutaneous revascularization procedures

Region	N	NE	SE	S	M	Mean
1995	19.0	4.9	5.1	5.7	5.4	5.3
1996	0.0	4.0	5.2	5.1	5.7	5.1
1997	2.3	3.4	4.7	5.1	5.2	4.8
1998	1.0	3.1	4.9	5.2	5.4	4.8
1999	0.0	3.3	4.6	5.2	4.7	4.6
2000	9.0	3.3	4.4	4.7	5.5	4.4
2001	6.0	3.6	4.2	4.5	4.4	4.2
2002	4.7	4.3	4.1	4.1	4.1	4.1
2003	3.6	3.6	3.8	4.3	5.0	4.0
2004	4.1	3.5	3.7	4.3	5.4	4.0
2005	4.1	2.7	3.2	3.8	3.3	3.4
2006	3.4	2.8	3.3	3.6	3.3	3.3
2007	4.9	2.8	3.1	3.6	3.5	3.3
2008	4.7	2.9	3.4	3.7	2.8	3.4
2009	4.0	3.2	3.6	4.0	3.2	3.7
2010	3.2	3.2	3.6	4.1	3.2	3.7
2011	4.2	3.4	3.6	4.2	3.3	3.7
2012	4.0	3.6	3.7	4.2	3.3	3.8
2013	3.9	3.6	3.7	4.2	3.3	3.8
2014	3.7	3.7	3.5	4.3	3.5	3.8
2015	3.8	3.6	3.6	4.2	3.3	3.7

Abbreviations: N: Northern region; NE: Northeastern region; SE: Southeastern region; S: Southern region; M: Midwest region.

For comparative purposes, the inflation of the Real Plan, as measured by the IPCA and accumulated between July 1994 and December 2014, was 373.5%, with a mean of 7.6% per year. Considering an inflation rate of 10.67% in 2015, the cumulative inflation rate during the study period was 384.17%, showing a dissociation in the progression curves between the paid amounts and the national economic scenario.

Conclusions

Considering the presented data, the possibility of information underreporting to the SUS data management system must be highlighted. There may also have been inaccuracies due to the use of mean values, in which the process of homogenizing the results with significant variation arising from distinct regions or, even, from annual outliers may be subject to criticism. In this sense, the extrapolation of these parameters with the objective of comparing health care services without overlapping characteristics should be treated with caution.

There was a visible increase in the number of procedures, with a substantial increase in the number of all groups of procedures, led by percutaneous versus surgical procedures from 2000 onwards. Among the groups, the hospitalization and mortality rates, in

Table 4 – Mean mortality rates (in percentage) by geographic region and year of processing for percutaneous revascularization procedures

Region	N	NE	SE	S	M	Mean
1995	0.0	2.3	1.8	2.8	2.3	2.2
1996	0.0	1.9	1.9	2.8	4.2	2.2
1997	0.0	1.8	1.9	3.0	4.7	2.3
1998	50.0	2.1	2.0	2.9	2.3	2.3
1999	0.0	2.4	1.9	3.4	2.8	2.4
2000	0.0	2.1	1.9	2.9	3.3	2.3
2001	0.0	2.4	1.8	2.9	3.5	2.3
2002	0.0	2.0	1.9	2.6	3.7	2.2
2003	0.5	2.5	1.8	2.3	2.9	2.1
2004	1.5	2.3	1.8	1.9	3.3	2.0
2005	1.5	1.7	1.2	1.5	1.9	1.4
2006	0.9	2.2	1.3	1.4	1.1	1.4
2007	1.1	2.1	1.0	1.7	1.4	1.4
2008	1.5	2.5	1.2	1.3	1.2	1.4
2009	1.4	2.6	1.6	1.8	1.8	1.8
2010	2.0	2.6	1.5	1.6	1.6	1.7
2011	2.0	2.6	1.6	1.9	1.9	1.9
2012	2.2	3.1	1.7	2.0	2.1	2.0
2013	2.4	3.2	1.7	2.0	2.4	2.1
2014	2.4	2.7	1.6	2.2	2.4	2.0
2015	3.1	2.7	1.9	2.2	2.6	2.2

Abbreviations: N: Northern region; NE: Northeastern region; SE: Southeastern region; S: Southern region; M: Midwest region.

general, presented a slight decrease or remained stable. Finally, even though the amounts paid to hospitals and health care professionals increased during the study period, they remained on average well below the inflation rate, especially in the percutaneous revascularization group.

Author contributions

Conception and design of the research: Bienert IRC, Andrade PB. Acquisition of data: Harada EA, Silva KL, Valente AR. Analysis and interpretation of the data: Bienert IRC, Rodrigues A, Silva PA, Braga JCMS, Rinaldi FS, Andrade PB. Statistical analysis: Rinaldi FS. Writing of the manuscript: Bienert IRC, Harada EA, Silva KL, Valente AR. Critical revision of the manuscript for intellectual content: Bienert IRC, Rodrigues A, Silva PA, Braga JCMS, Guimarães Filho FV, Andrade PB.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

There were no external funding sources for this study.

Study Association

This study is not associated with any thesis or dissertation work.

Table 5 – Mean length of hospital stay (in days) by geographic region and year of processing for primary percutaneous revascularization procedures

Region	N	NE	SE	S	M	Mean
1995	7.6	5.2	5.1	6.0	6.1	5.3
1996	7.9	6.0	5.6	6.6	6.9	6.0
1997	6.6	5.9	6.3	6.3	5.7	6.2
1998	7.1	5.3	6.3	6.1	5.9	6.1
1999	5.7	5.7	5.9	5.6	5.5	5.7
2000	7.7	5.7	5.7	5.7	5.1	5.7
2001	4.3	5.7	5.6	5.7	5.2	5.6
2002	6.1	5.6	5.6	5.4	5.7	5.5
2003	6.8	5.8	5.6	5.4	6.8	5.6
2004	6.6	6.2	5.8	5.3	5.8	5.7
2005	6.7	5.9	5.6	5.4	4.8	5.6
2006	4.5	5.6	5.5	5.8	4.9	5.6
2007	7.6	5.2	5.1	6.0	6.1	5.3
2008	7.9	6.0	5.6	6.6	6.9	6.0
2009	6.6	5.9	6.3	6.3	5.7	6.2
2010	7.1	5.3	6.3	6.1	5.9	6.1
2011	5.7	5.7	5.9	5.6	5.5	5.7
2012	7.7	5.7	5.7	5.7	5.1	5.7
2013	4.3	5.7	5.6	5.7	5.2	5.6
2014	6.1	5.6	5.6	5.4	5.7	5.5
2015	6.8	5.8	5.6	5.4	6.8	5.6

Abbreviations: N: Northern region; NE: Northeastern region; SE: Southeastern region; S: Southern region; M: Midwest region.

Table 6 – Mean mortality rates (in percentage) by geographic region and year of processing for primary percutaneous revascularization procedures

Region	N	NE	SE	S	M	Mean
1995	5.88	11.2	6.41	8.97	6.56	7.94
1996	7.91	6.2	5.91	8.67	5.74	6.65
1997	9.69	6.99	6.06	7.29	11.21	6.9
1998	7.69	7.06	6.82	8.45	8.71	7.44
1999	9.13	6.12	6.26	7.36	8.74	6.77
2000	5.76	7.1	6.57	7.17	6.72	6.87
2001	8.78	7.17	7.83	6.13	14.48	7.33
2002	7.04	7.15	7.89	6.95	9.55	7.44
2003	6.88	8.06	7.43	7.01	9.03	7.43
2004	5.39	8.66	6.75	6.39	8.08	6.96
2005	7.38	5.61	7.21	5.51	8.42	6.33
2006	6.77	6.13	7.18	6.56	6.05	6.66
2007	5.88	11.2	6.41	8.97	6.56	7.94
2008	7.91	6.2	5.91	8.67	5.74	6.65
2009	9.69	6.99	6.06	7.29	11.2	6.9
2010	7.69	7.06	6.82	8.45	8.71	7.44
2011	9.13	6.12	6.26	7.36	8.74	6.77
2012	5.76	7.1	6.57	7.17	6.72	6.87
2013	8.78	7.17	7.83	6.13	14.48	7.33
2014	7.04	7.15	7.89	6.95	9.55	7.44
2015	6.88	8.06	7.43	7.01	9.03	7.43

Abbreviations: N: Northern region; NE: Northeastern region; SE: Southeastern region; S: Southern region; M: Midwest region.

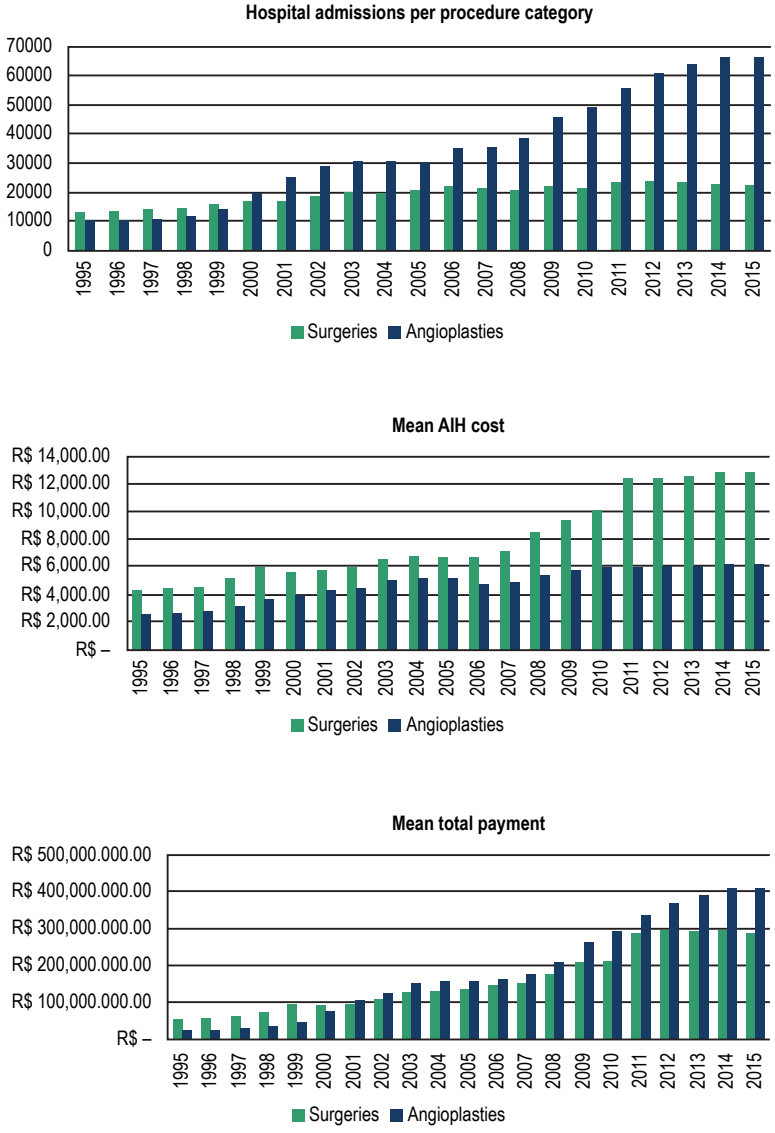

Figure 2 – *Comparison according to group of procedure, per year.*

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