ORIGINAL ARTICLE

Impact of Risk Factors for Coronary Artery Disease on Hospital Costs of Patients Undergoing Myocardial Revascularization Surgery in the Brazilian Unified Health System (SUS)

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Abstract

Background: Cardiovascular diseases are a major cause of mortality and morbidity. Myocardial revascularization surgery may be indicated for the relief of symptoms and to reduce mortality. However, surgery is a costly procedure and the impact of the number of cardiovascular risk factors on the cost of the procedure has not been established.

Objectives: To identify the impact of risk factors for coronary artery disease on myocardial revascularization surgery cost.

Methods: We selected 239 patients undergoing myocardial revascularization surgery at the National Institute of Cardiology in the period from 01 January to 31 December 2013. We included patients aged over 30 years, with indication for the procedure. Patients undergoing combined procedures were excluded.

Results: Seven patients had only one risk factor, 32 patients had two risk factors, 75 patients had 3 risk factors, 78 patients had four risk factors, 36 patients had 5 risk factors and 11 patients presented 6 risk factors. The total costs, on average, was R$ 14,143.22 in the group with 1 risk factor, R$ 18,380.40 in the group with 2 risk factors, R$ 21,229.51 in the group with 3 risk factors, R$ 24,620.86 in the group with 4 risk factors, R$ 21,337.92 in the group with 5 risk factors and R$ 36,098,35 in the group with 6 risk factors (p = 0.441).

Conclusion: This study demonstrates that, in a public referral center for highly complex cardiology procedures, there was no significant correlation between the number of cardiovascular risk factors and hospitalization costs. (Int J Cardiovasc Sci. 2018;31(2)90-96)

Keywords: Coronary Artery Disease; Myocardial Revascularization / economics; Risk Factors; Hospital Costs; Unified Health System.

Introduction

Cardiovascular diseases are a major cause of mortality and morbidity.[1] In a national context, the prevalence of ischemic heart disease has increased in the past years, leading to an increase in hospitalizations and health costs.[2] Myocardial revascularization surgery (MRS) is an expensive therapy, indicated to selected patients. Clinical conditions of patients prior to MRS can have an important influence on the procedure costs. However, there is little information regarding the impact of cardiovascular risk factors related to the development of coronary artery disease (CAD) on MRS costs at a national level. The aim of this study was to investigate the impact of risk factors on MRS costs in the Brazilian Unified Health System (SUS).

Methods

This was an observational, prospective, unicenter study. A total of 239 consecutive patients who had undergone MRS at the National Institute of Cardiology were selected. This is a public tertiary hospital that serves SUS users referred for high complexity cardiology procedures from 01 January 2013 to 31 December 2013.

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We included patients aged over 30 years, of both sexes, with indication for MRS and CAD confirmed by coronary angiography. Patients who had undergone MRS combined with other surgeries including valve surgeries, carotid endarterectomy, vascular surgeries were excluded. Systemic hypertension, diabetes mellitus, dyslipidemia, current or past smoking, sedentary lifestyle, chronic renal failure and obesity were considered risk factors for CAD. Hospitalization costs related to medications, laboratory tests, imaging tests, materials, and healthcare professionals, provided by the cost center, were collected from patients' medical records. We used the micro-costing method, in which each intervention performed was individually counted for the total hospitalization costs. The values used as basis of cost estimation were obtained from the Table of Procedures and Medications of SUS Managing System (SIGTAP).

Exploratory analysis of the frequencies of categorical variables was performed. Continuous variables were presented as mean, median and other measures of central tendency, dispersion and data ordering, as appropriate. Categorical variables were analyzed by the chi-square test. P-values < 0.05 were considered statistically significant. The SPSS 20.0 (IBM) was used for the analysis. The present study was approved by the Ethics Committee (approval number 648089), and the study was performed according to the Helsinki declaration.

Results

A total of 239 patients presenting from 1 to 6 cardiovascular risk factors were evaluated. Seven patients had only one risk factor, 32 patients had two risk factors, 75 patients had three risk factors, 78 four risk factors, 35 had five risk factors and 11 patients had six risk factors.

Patients' characteristics and definitions of cardiovascular risk factors are described in Table 1 and Table 2, respectively.

Patients with a higher number of comorbidities showed higher BMI as compared with patients with less risk factors (p < 0.001). Mean age was not significantly different between the groups.

The prevalence of cardiovascular risk factors was variable among the subjects, and the most frequent ones were systemic arterial hypertension and dyslipidemia, found in 95.8% and 76.6% of patients, respectively. The prevalence of the risk factors analyzed in the study is shown in Figure 1.

Table 3 displays hospitalization costs analyzed by the micro-costing approach, stratified as medications, laboratory tests, imaging tests, materials, professionals and common costs.

The occurrence of complications during hospitalization was not significantly different between the groups (Table 4). Deaths were proportional to the number of subjects in each group, with no significant differences between the groups. The numbers of hospital days and ICU days were not different between the groups.

Discussion

Results of this study represent the costs of MRS alone, encompassing the whole hospitalization period, in a referral hospital for cardiology diseases in the SUS.

A number of studies have suggested that demographic characteristics of patients, including older age, female sex, left ventricular ejection fraction, number of coronaries involved, previous surgeries and high number of comorbidities, may significantly affect MRS hospital costs.[3] However, an analysis under this perspective has not been performed in Brazil yet.

Patients of the present study showed a higher prevalence of hypertension, diabetes mellitus, and left coronary artery lesion as compared with patients of similar reports.[4]

In all categories, there was a direct relationship between costs and the number of risk factors, with no statistical significance though. Other studies have shown a positive correlation between cardiovascular risk factors and hospital costs.[5,6] Nevertheless, there is evidence suggesting that local factors, such as the country and even the level of hospital complexity may influence the effects of cardiovascular risk factors on hospital costs.[7]

In the present study, no significant differences in demographic variables, cause of hospitalization, ventricular function or angiographic data were found between the groups. There were differences in the clinical history and comorbidities between the groups; these differences, though, were expected, since the characterization of the groups was based on the presence and the number of comorbidities.

In addition, no differences were found with respect to patients' complications, which account for a considerable percentage of hospitalization costs, not only for the increase in the hospital or ICU stay, but also for the increased use of resources.[8] Nevertheless, other studies have reported a correlation between risk factors and complications during hospitalization,[9] which may lead to higher hospital-related costs.

Table 1 – Patients' characteristics							
	Number of cardiovascular risk factors						
	1	**2**	**3**	**4**	**5**	**6**	**p**
Demographic profile							
Number of patients /group	7	32	75	78	36	11	
Age, mean (± SD)	62.6 (8.7)	63.6 (8.0)	62.0 (10.0)	62.0 (8.1)	59.3 (8.2)	59.3 (8.8)	0.387
Male, n	6	24	51	52	28	7	0.699
Anthropometric data, mean (± SD)							
Weight (Kg)	67.1 (10.0)	73.8 (16.4)	73.1 (11.9)	77.7 (13.1)	79.9 (15.4)	87.6 (15.4)	0.002
Height (m)	1.62 (0.09)	1.66 (0.10)	1.65 (0.10)	1.64 (0.08)	1.62 (0.06)	1.67 (0.12)	0.421
BMI (kg/m²)	25.7 (3.3)	26.5 (4.0)	26.9 (3.8)	28.9 (4.2)	30.3 (5.4)	31.4 (4.3)	< 0.001
Cause of hospitalization, n							
Stable CAD without angina	0	3	4	2	2	1	
Stable angina	5	18	40	45	18	3	
Unstable angina	0	4	14	14	6	2	0.743
NSTEMI	1	4	11	7	5	3	
STEMI	1	2	5	8	5	2	
Others	0	1	1	2	0	0	
Clinical history, n							
Systemic arterial hypertension	2	29	73	78	36	11	< 0.001
Diabetes mellitus	0	5	25	44	26	10	< 0.001
Dyslipidemia	2	11	60	69	31	10	< 0.001
Current smoking	2	3	12	26	19	5	< 0.001
Past smoking	1	10	25	28	13	6	0.624
Sedentary lifestyle	0	1	5	14	21	10	< 0.001
Previous myocardial infarction	2	16	43	40	19	7	0.710
Previous coronary angioplasty	0	1	6	11	3	1	0.479
Arrhythmia	0	0	2	2	1	0	0.930
Family history of CAD	0	2	10	11	12	4	0.009
Peripheral artery disease	0	1	6	7	4	2	0.615
Carotid artery disease	0	0	2	4	0	0	0.495
Chronic kidney disease	0	0	3	9	5	2	0.087
Chronic obstructive pulmonary disease	0	1	6	1	3	0	0.299
Alcoholism	0	2	5	4	1	0	0.869
Illicit drug use	0	0	1	3	0	0	0.588
Previous stroke	0	1	3	2	3	0	0.681
Hypothyroidism	0	1	1	5	1	0	0.571
Obesity	0	3	12	33	17	8	< 0.001

Continuation

Left ventricular function, n

Normal	3	17	44	49	21	5	
Mild dysfunction	2	7	11	4	5	4	0.998
Moderate dysfunction	2	7	9	10	2	1	
Severe dysfunction	0	1	11	15	7	1	
Mean left ventricular ejection fraction (%)	56	56	56	56	55	56	0.999
Angiographic data, n							
LCA lesions	1	11	26	22	7	7	0.112
Three vessel disease	5	23	46	52	24	5	0.453
Hospitalization data							
Days of hospital stay	22.8	29.8	31.4	34.1	31.1	41.1	0.527
Days of ICU stay	5	5	6	8	8	17	0.080
Duration of ECC (minutes)	115	96	101	99	85	93	0.102
Surgeries without ECC	1	4	3	6	3	1	0.695

BMI: body mass index; CAD: Coronary artery disease; NSTEMI: non-ST segment elevation myocardial infarction; STEMI: ST-elevation acute myocardial infarction; ICU: intensive care unit; LCA: left coronary artery; ECC: extracorporeal circulation

Table 2 – Definitions of cardiovascular risk factors

Risk factor	Definition
Systemic arterial hypertension	Arterial pressure $\geq$ 140x90 mmHg (measured by the physician)
Diabetes mellitus	Fasting glucose $\geq$ 126 mg/dL on more than one occasion or non-fasting glucose $\geq$ 200 mmHg
Dyslipidemia	LDL-cholesterol $\geq$ 130 mg/dL or total cholesterol total $\geq$ 200 mg/dL or Triglycerides $\geq$ 150 mg/dL
Current smoking	Self-reported use of any tobacco product within the last 30 days
Past smoking	Self-reported use of any tobacco product in the past, and cessation at least 30 days before the study
Sedentary lifestyle	Practice of physical activities for less than 150 minutes a week
Family history of CAD	CAD in first-degree relatives younger than 55 years (men) or 65 years (women)
Chronic kidney disease	Glomerular filtration rate lower than 90 mL/min
Obesity	Body mass index $\geq$ 30 kg/m^2

LDL: Low density lipoprotein; CAD: coronary artery disease

Also, we found no significant differences in hospitalization data between the groups. This finding is relevant, since duration of hospital stay and ICU stay are strong determinants of total hospitalization costs.[10]

In this study, the micro-costing method enabled a more accurate estimation of the hospitalization costs at patient level, including a more refined analysis of the costs related to medication, laboratory tests, complementary imaging tests, materials and professionals.

Clinical scores used to assess complication and mortality risk in MRS, such as EuroSCORE[11] and the STS score,[12] estimate the occurrence of events based on the presence of comorbidities and cardiovascular risk
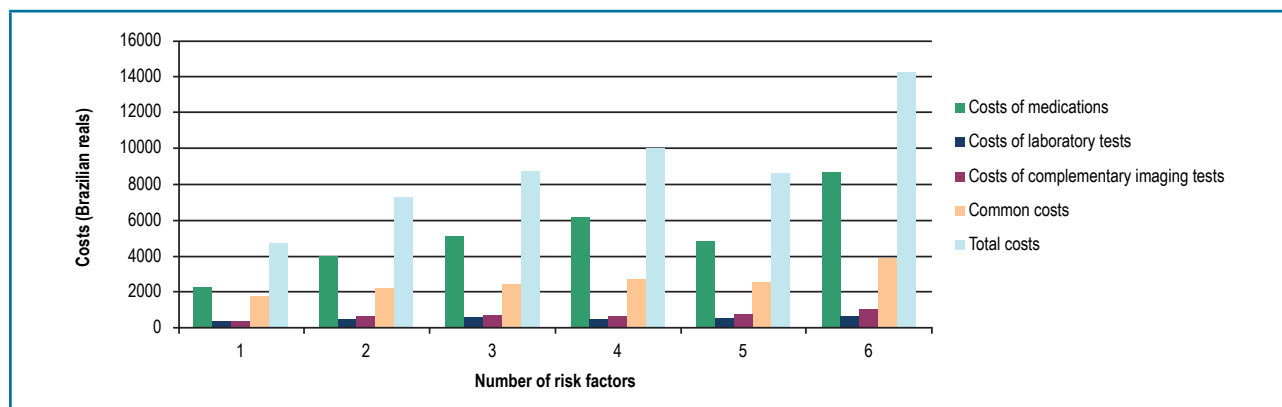
Figure 1 – *Average costs stratified by patients categorized by number of cardiovascular risk factors (in Brazilian reals)*

Table 3 – Hospitalization costs (in Brazilian reals) by number of cardiovascular risk factors

	Number of cardiovascular risk factors						
	1	**2**	**3**	**4**	**5**	**6**	**p**
Medications	1,809.58	3,358.82	4,372.45	5,461.54	4,090.17	7,661.63	0.946
Laboratory tests	451.24	530.30	613.99	563.60	601.21	824.16	0.685
Complementary imaging tests	284.30	547.22	609.90	534.02	598.29	872.86	0.448
Materials	2,170.45	2,181.64	2,535.56	2,616.95	2,213.19	3,279.91	0.600
Professionals	5,835.67	7,346.73	7,996.76	9,137.31	8,276.91	12,874.42	0.393
Common costs	3,591.97	4,415.69	5,100.86	6,307.44	5,558.16	10,585.36	0.186
Total costs	14,143.22	18,380.40	21,229.51	24,620.86	21,337.92	36,098.35	0.441

Table 4 – Complications during hospitalization by number of cardiovascular risk factors

	Number of cardiovascular risk factors						
	1	**2**	**3**	**4**	**5**	**6**	**p**
Infectious complications	1	5	11	9	7	3	0.763
Cardiovascular complications	1	6	11	12	6	1	0.984
Arrhythmias	2	3	8	5	6	2	0.329
Bleeding	0	3	7	6	1	0	0.664
General complications	3	13	35	23	17	5	0.317
Death	1	4	11	6	3	2	0.998

factors. However, in this study involving patients with one to six risk factors, complications rates and costs were not different between the groups.

One limitation of this study was the fact that the groups with the highest and the lowest numbers of risk factors were also the groups with the lowest number of patients, which may make the detection of significant differences between the groups difficult. In addition, the lack of significant differences may be due to the small number of patients in some groups.

Our results may contribute to a better control of costs and optimization of resource allocation by public health managers. The use of the micro-costing approach places the costs of each patient as a priority, taking into account the costs of each intervention the patient receives during hospital stay.

Further studies may use the micro-costing method to get a more detailed understanding of the costs of the MRS procedure in the public and in the private health systems.

Author contributions

Conception and design of the research: Barbosa JL. Acquisition of data: Barbosa JL, Cunha CFS, Moutella J, Orsi GP, Feldman K, Silva NR, Faria LF. Analysis and interpretation of the data: Barbosa JL, Thiers CA, Cunha CFS, Moutella J, Tura BR, Orsi GP, Feldman K, Silva NR, Faria LF. Statistical analysis: Barbosa JL. Obtaining financing: Barbosa JL. Writing of the manuscript: Barbosa JL, Thiers CA. Critical revision of the manuscript for intellectual content: Barbosa JL, Thiers CA, Tura BR. Supervision / as the major investigador: Barbosa JL.

Potential Conflict of Interest

Sources of Funding

Study Association

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Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Instituto Nacional de Cardiologia under the protocol number 648089. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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