Review Article

Myocardial Revascularization Surgery (MRS). Results from National Health System (SUS)

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Abstract

Background: Myocardial revascularization surgery (MRS) is the most common surgery in this country, with most being performed through the National Health System(SUS).

Objectives: To assess MRS results when not associated to other procedures.

Methods: The information from the Hospital Information System (SIH/DATASUS) made available online was submitted to analysis. The data include information on gender, age, hospital stay period, hospital admission authorization (AIH) costs, number of surgeries at each hospital, and in-hospital mortality rate. Only MRS with no associated procedures were analyzed.

Results: A total of 63,529 surgeries were performed in the period between 2005 and 2007 at 191 hospitals. Sixteen hospitals reporting very low surgery volume were excluded. The remaining total number of surgeries came down to 63,272 for the final analysis. In-hospital mortality rate was 6.22%, with small surgery volume hospitals reporting higher rate than high volume hospitals (≥ 300 surgeries in the time period under study), 7.29% versus 5.77% (p<0.001). Average hospital stay time length was 12 days, with no difference having been reported between low (12.08 ± 5.52) and high volume (12.15 ± 7.70) hospitals. Males reported lower mortality rate than females - 5.20% versus 8.25% (p<0.001), similarly to younger individuals when compared to the elderly (≥ 65 years of age), 4.21% versus 9.36% (p<0.001). A slight variation was observed in AIH values between the Southern Region (R$ 7.214,63 - approximately US$ 3,600.00) and the Northeastern Region (R$ 6.572,03 – approximately US$ 3,280.00) (p<0.01). Regional distribution of surgeries was not comparable in all regions in the country, with Southern and Southeastern Regions having reported 77% of them.

Conclusion: MRS performed by SUS has reported high mortality rate in low volume hospitals, among women, and among the elderly. Future prospective studies are deemed to be necessary.

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Introduction

Despite the advances brought by clinical therapeutics and PCI, myocardial revascularization surgery is still quite widely used to treat coronary failure patients.

SUS is one of the largest health care systems in the world, having reported 11,315,333 hospital admissions in 2007 for the total Brazilian population (189,335,187) – a 6% admission rate. It should be pointed out that 21.07% of that population has some kind of private health insurance coverage1.

Myocardial revascularization surgery (MRS) is the most frequent from all heart surgeries performed by SUS both at public hospitals and at private or philanthropic ones, involving over one hundred surgery teams.

It has been estimated that SUS is responsible for 80% of all MRS in this country. Those surgeries are qualified for reimbursement to the hospitals rendering that service. Data are submitted to auditing. AIH, in-hospital stays, and mortality rate - among others - are made available for public consultation on SUS Data Base (DATASUS). Up to this point in time, the same data in reference to surgeries performed by the Supplementary Medicine System or the Private System are not available for consultation2.

The purpose of this paper was to assess MRS results in order to measure the quality standard of services provided by SUS through system available variables, as follows: Gender, age, geographic location, number of surgeries performed, in-hospital time period and hospital expenses.

Methods

Analysis data on MRS were obtained from SUS Hospital Information System (SIH) - SIH/DATASET3. That Data Base is operated by the Ministry of Health, is submitted to auditing, and collects information on hospital admittance for every patient at hospital admission. It is also the tool used to control payment of the amounts due to hospitals rendering services.

Data analysis was based on information from the period between 2005 and 2007, since that not only was the most recent information available but also showed the indications and surgery techniques currently in use.

MRS was investigated in cases where it was performed as an

isolated procedure. Cases using associated surgical procedures (prostheses and valvuloplasty, aneurysm correction, and carotid endarterectomy) were excluded. Therefore, in the classification of SUS procedures the following codes were selected: 48010073 (MRS with extracorporeal circulation); 48010081 (MRS with extracorporeal circulation and double grafting or more); 48010090 (MRS without extracorporeal circulation), 48010103 (MRS without extracorporeal circulation with double grafting or more). That means to say: only isolated procedures used for myocardial revascularization with or without extracorporeal circulation.

In order to verify the differences between high and low production volume hospitals, they were divided into two groups. The very low production hospitals were excluded. A very low production hospital meant not more than one surgery per month in the three-year period. A high volume hospital was defined as that with records of 100 or more isolated MRS per year. Following such grouping, the low volume hospitals had records between 37 and 299 MRS, whereas high volume, 300 or more surgeries. Sixteen hospitals were excluded. They had records of 36 or minus surgeries in the three-year period (257 surgeries, 0.40% of the total number).

The number of MRS with associated procedures – not included in the present analysis – was 6,256, which represents 8.96% of the total number of MRS.

Results were also analyzed taking gender and age into account, as well as reimbursement amounts for hospital expenses (AIH based), and patients' hospital stay.

Statistical Analysis

Qualitative variables are presented percentage wise. Comparisons were performed using $\chi 2$ (chi-square). Means, standard deviation, minimal and maximal values were calculated for quantitative variables. Comparisons of two means were done using Student t test or Mann-Whitney's non-parametric test whenever necessary.

For the simultaneous comparison of a number of means, one criterion-variance analysis was used. Scheffé's test was used for multiple comparisons. Whenever indicated, Kruskal-Wallis's non-parametric test was used for those comparisons. Significance level was defined to be $p < 0.05$.

Results

In the period between 2005 and 2007, 63,529 isolated MRS were performed by SUS (2005: 20,337; 2006: 21,848; 2007: 21,344 patients) at 191 hospitals in Brazil. After all the exclusions, 63,272 isolated MRS performed at 175 hospitals remained for analysis. Global in-hospital mortality

rate was 6.22%. In the three-year period, 55 (30%) hospitals performed over 300 isolated MRS, with a total of 44,539 (70%) surgeries.

Table 1 shows in-hospital mortality rate according to volume – low or high volume – of surgeries performed in that period. Higher mortality rate was observed at low volume hospitals, which are bigger in number. They accounted for 30% of the surgeries – 7.29% versus 5.77% (p<0.001) respectively. At high volume hospitals in-hospital mortality ranged from 1.91 to 19.13% (Figure 1); at low volume hospitals (120 hospitals with 18,733 surgeries) it ranged from 0.00 to 35.71 (mean = 7.29%).

Table 2 shows in-hospital mortality rate in different Brazilian regions. Differences are statistically significant (p<0.001), with the highest death rate having been observed in the Central Western Region, and the lowest in the Northeastern Region.

Table 3 shows mortality rate per gender and age of patients who have been submitted to the surgery. Males have reported lower mortality rate than females – 5.20% versus 8.25% (p<0.001). Likewise, younger patients (0-64 years old) when compared to the elderly (=>65 years of age) – 4.21% versus 9.36% (p<0.001).

Table 4 shows mean time period for hospital stay in number of days and AIH average cost in Brazilian currency respectively to each physiographic region. The differences between time length at hospital have not been found to be statistically significant (p>0.05). The differences between AIH mean values were statistically significant when Southern and Northeastern regions were compared - R$ 7.214,63 versus R$ 6.572,03 (p<0.01) respectively.

Table 5 shows the comparison between mean in-hospital time length (number of days) and AIH mean values following surgery volume at hospitals. It should be pointed out that such difference is not significant for any of the variables.

However, Table 6 also shows the comparison between public and private hospitals with high volume of isolated MRS in regard to in-hospital time length and AIH mean values. Significant difference could be observed between in-hospital time length – 16.54 versus 11.40 days (p<0.01). Such difference could not be observed between AIH values - R$ 6.990,16 versus R$ 6.864,74 (p>0.05), respectively.

Table 7 shows number of surgeries/population ratio in the five country regions. Thirty-four isolated MRS were performed in Brazil for every 100,000 individuals. A large difference could be observed in the number of procedures performed in each of the regions, having been the Southern region the most favored - 60/100,000 – and the Northern region the most unfavored - 9/100,000 – ratios respectively.

Table 1 - -hospital mortality rate among patients submitted to isolated MRS matched by hospital surgery volume

Volume	Nº of hospitals	%	Nº of surgeries	%	Nº of deaths	%
Low	120	69	18.733	30	1.365	7.29*
High	55	31	44. 539	70	2.569	5.77
Total	175	100	63.272	100	3.934	6.22

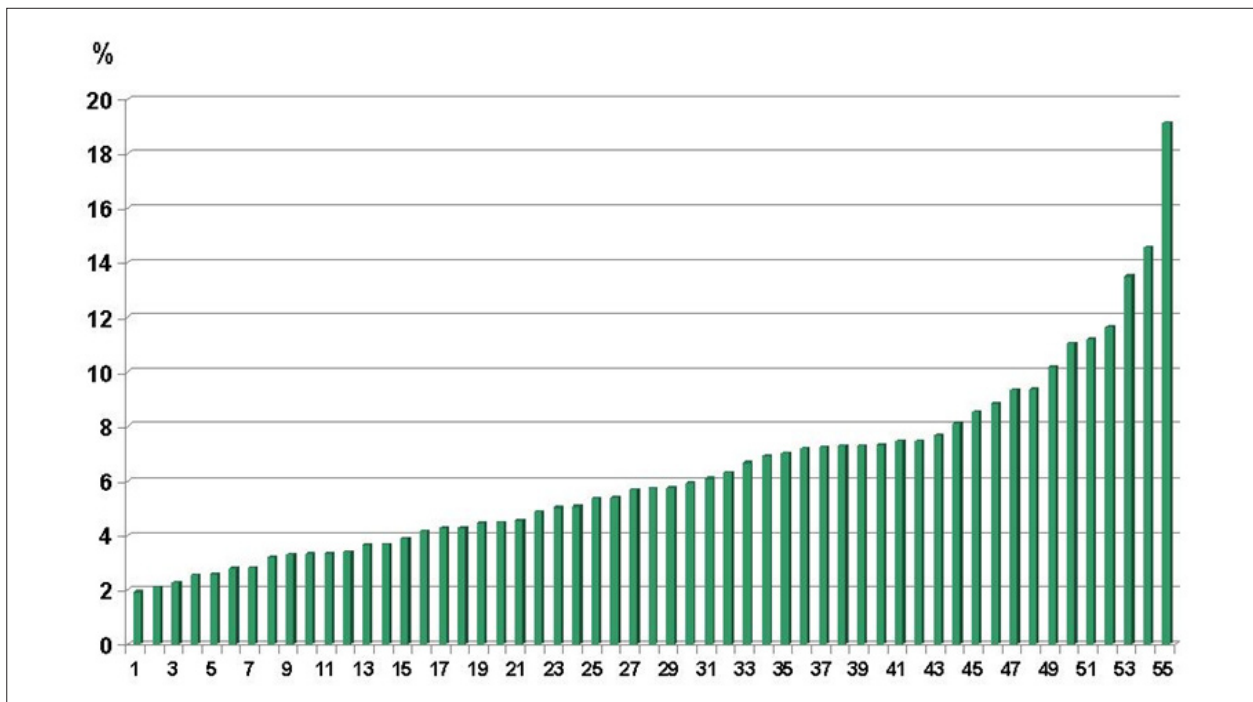*p<0.001

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Figure 1 - In-hospital mortality rate in the 55 hospitals with records of 100+ isolated myocardial revascularization surgeries in the period between 2005 and 2007.

Table 2 - In-hospital mortality rate per physiographic region

Regions	Nº of patients	%	Nº of deaths	%
Southeast	32,956	52.1	1,989	6.04
South	15,985	25.3	1,049	6.52
Northeast	9,284	14.7	478	5.12
North	1,354	2.1	98	7.24
Central West	3,693	5,.8	320	8.67
Brazil	63,272	100.00	3,934	6.22

p<0.001

Table 3 - In-hospital mortality rate among patients submitted to isolated MRS according to gender and age

		Nº de of patients	%	Nº of deaths	%
Gender	Males	42,120	67	2,190	5.20*
	Females	21,152	33	1,744	8.25
Age	0 to 64 y.o.	38,566	61	1,622	4.21*
	65 and older	24,706	39	2,312	9.36

*p<0.001

Table 4 - Mean time period for hospital stay in number of days and AIH average cost in Brazilian currency per physiographic region

Regions	Mean time	Minimum	Maximum	Average AIH (R$)	Minimum	Maximum
Southeast	12.53	5.71	39.88	6,839.86	5,770.81	8,996.99
South	12.16	6.42	31.93	7,214.63	6,304.19	8,732.93
Northeast	10.71	5.47	25.54	6,572.03	5,825.96	7,998.14
North	15.46	9.70	22.11	6,954.23	6,373.67	7,866.90
Central	11.35	6.27	31.13	6,576.67	5,773.32	8,125.36

AIH variation is significant when Southern and Northeastern regions are compared (p<0.01). Other comparisons are not significant, in-hospital stay included.

Discussion

Surgery data are compulsorily stored in the national system, audited, and operated by SUS Hospital Information System – SIH/DATASUS. For the purpose of treatment standardization, only isolated MRS were analyzed. Such choice was the standard group procedure.

A total of 79.03%1 in the Brazilian population has coverage for medical assistance by SUS. Most high

Table 5 - Average number of in-hospital days, average AIH value (RS$) according to hospital surgery volume

Volume	N° of hospitals	Mean	Standard Deviation	Minimum	Maximum
Average in-hospital stay					
Low volume hospital	120	12.08	5.52	5.47	39.88*
High volume hospital	55	12.15	7.70	6.42	31.93
AIH Average (R$)					
Low volume hospital	120	6,842.84	702.82	5,770.81	8,996.99*
High volume hospital	55	6,882.98	670.71	5,773.32	8,414.72

p>0.05.

Table 6 - Average number of in-hospital days, average AIH value (RS$) - comparison between public and private high volume hospitals

	Mean	Standard Deviation	Minimum	Maximum
Average stay (d)				
Public Hospitals(N=8)	16.54*	6.64	10.27	31.93
Private N=47	11.40	3.91	6.42	28.89
AIH Average (R$)				
Public Hospitals (N=8)	6,990.16**	323.26	6,572.97	7,422.98
Private N=47	6,864.74	714.04	5,773.32	8,414.72

*p<0,01 **p>0,05.*

Table 7 - Number of isolated MRS per 100,000 individuals in each region

Regions/ Country	Population	MRS	MRS / 100,000 individuals
North	14,623,316	1354	9
Northeast	51,534,406	9,284	18
Southeast	77,873,120	32,956	42
South	26,733,595	15,985	60
Central West	13,222,854	3,693	28
Brazil	183,987,291	63,272	34

IBGE – 2007.

complexity procedures are performed under that system. As an administrative system used for billing, the data base lacks clinical data such as risk factors, co-morbidities, surgery indications, physical examinations, and hospital complications, among others. On the other hand, the large number of surgeries performed and the basic data on in-hospital patients that is made available, such as gender, age, in-hospital mortality rate, and number of surgeries per hospital make up a reliable data base for results per hospital, per region, per total or any other grouping to be assessed. The high number of surgeries under analysis is expected to set forth uniform guidelines for the possible deviations that may be found in less wide-reaching studies.

In 2007 – the last year in the 3-year analysis – a slight reduction in the number of surgeries could be observed, most likely as a result of the growing number or percutaneous coronary interventions (PCI).

Mortality rate was found to be 6.22% for a total of 63,272 patients in the present study. Although higher as compared to other countries, it is similar to what was reported by Ribeiro and cols. for the period between 2003-2004, and based on data from the same data base (SIH/DATASUS)[4]. The authors reported a 7% mortality rate for a total of 65,716 patients who had been submitted to coronary surgery (their research also included coronary surgeries with associated procedures). Mesquita et al[5] conducted assessed a small series of 114 consecutive patients submitted to isolated MRS at a Rio de Janeiro hospital. Surgery mortality rate was reported to be

4.9%[5]. The Journal Adult Cardiac Surgery in New York State 2003 – 2005 reports a 2.14% in-hospital mortality rate within 30 days for a total of 40,429 patients submitted to isolated coronary surgery and who were operated on and discharged from hospital in the time period between 2003 and 2005[6]. In that study, mortality rate per hospital ranged from 0.76 to 4.01%. In 1995, mortality rates reported for a total of 11,731 patients who had been submitted to isolated coronary surgery in six different countries in the voluntary project European System for Cardiac Risk Evaluation (EuroSCORE) were: Germany – 2.4%; United Kingdom – 3.7%; Spain – 6.8%; Finland – 1.5%, France – 3.2%, Italy – 2.4%. Average – 3.4%[7]. A retrospective study with 3,670 patients consecutively submitted to isolated MRS at a hospital in New York State reported a 2.7%[8] in-hospital mortality rate. Despite the limitations for the comparison between the different series submitted to the same surgery, a lower mortality rate could be observed both in Europe and in the United States when compared to Brazil.

Although low volume surgery hospitals may present good results, the ratio lower surgery volume / higher mortality rate is typically found[9]. For MRS in particular, any volume lower than 100 surgeries per year is usually associated to higher mortality rate[10]. The same study shows that even higher volume hospitals report differences that will deserve further future investigation. One of the possible explanations is associated to the different teams working at the same hospital.

Similar studies have reported higher mortality rate among females and the elderly[11,12]. Females presenting a coronary atherosclerosis condition typically present less clear

impairment of vessel wall injuries (usually lower caliber), and consequently a more severe form of the condition. While studying 2,034 patients - 69% of them males and 31% of them females – Amato and cols. observed a 4.9% mortality rate among males and 6.3% among females13.

In-hospital stay did not vary in the different regions. However, it was shown to be longer at high surgery volume public hospitals when compared to private hospitals. That could mirror better administration and/or higher funding and autonomy at private hospitals.

AIH showed to have slight regional variation. It was lower in the Northeastern region if compared to the Southern region. AIH is usually used to calculate hospital stay costs, but it is hardly informative for funding studies since it mirrors the payment for a non-elastic package in terms of constitution rather than the proper allocation of funding for the calculation of the real cost of procedures. AIH does not actually mirror the real cost of procedure, but rather the reimbursement of amounts previously defined by services rendered. In a recent study, Haddad et al14 have shown that compensation by SUS is lower than the real cost of surgery, even at public hospitals where it is partially subsidized by some government organ. Hardly any study is available on the cost of procedures.

High disparity can be observed in the number of surgery / population ratio in the different regions. A clear relationship can be seen between social and economic development. The Southern and the Southeastern regions report the highest number of surgeries per individuals when compared to the Northern and Northeastern regions. The Southern and Southeastern regions account for 77% of the surgeries. Such disparity is associated to a higher number os hospital beds and specialized hospitals in those regions. Mortality rate was similar, although a slight difference could be observed to favor the Northeastern region when compared to the Central Western region.

Some European countries as well - such as The United Kingdom, Spain, Finland, and France – do present differences in the number of myocardial revascularization surgeries per 100,000 individuals – 44.4, 16.2, 92.1 and 40.815 respectively.

Quite a number of variables unquestionably interfere in the outcome of a successful] MRS, among them whether the surgery is an urgency/emergency, whether it is associated to

risk factors such as obesity, associated morbidities, number of impaired arteries, reduced ventricular function, post-operative complications, the number of surgeries performed by the team, other situations when risk is increased, thus unveiling the complexity of studies such as the present one.

Limitations

The major limitation faced by the present study was the fact that it did not count on clinical data on patients submitted to the surgery. Not only age and gender are key contributors for surgery results, but the conditions under which the surgery was performed as well as patient's status. The lack of such information hinders mortality rate adjustment according to patient's severity.

Another factor is that different surgery teams work at the same hospital. Not always do those teams reach the same results, which may interfere in the outcome.

Conclusions

The present study analyzed isolated myocardial revascularization surgeries performed by SUS in the period between 2005 and 2007. The study showed higher in-hospital mortality at lower surgery volume hospitals, among women, and among the elderly. Mortality rate was higher than that observed in some countries, although similar to other countries. The comparison faced difficulties from the lack of clinical variables and risk adjustments in the data base used for consultation. Future prospective studies must take those factors into account.

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 post-graduation program.

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