

# Implementation of the Myocardial Infarction System of Care in City of Belo Horizonte, Brazil

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## Abstract

**Background:** The creation of an acute myocardial infarction (AMI) management systems is aimed at optimizing the management of patients from early diagnosis to proper and timely treatment.

**Objective:** To assess the implantation of an AMI management system in the municipality of Belo Horizonte, state of Minas Gerais, and its impact on in-hospital mortality due to AMI.

**Methods:** The AMI management system was implanted in the municipality of Belo Horizonte between 2010 and 2011, aiming at increasing the access of patients of the public health system to the treatment recommended by the existing guidelines. The teams at the prompt care units were trained, and the system of tele-electrocardiography was implanted in those units. The primary outcomes of this retrospective observational study were the number of admissions and in-hospital mortality due to AMI, from 2009 to 2011.

**Results:** In the period studied, 294 professionals were trained and 563 electrocardiograms (ECGs) transmitted from prompt care units to coronary units. A significant reduction was observed in the in-hospital mortality rate (12.3% in 2009 versus 7.1% in 2011,  $p < 0.001$ ), while the number of admissions due to AMI remained stable. The mean cost of admission increased (mean R\$ 2,480.00 versus R\$ 3,501.00;  $p < 0.001$ ), the proportion of admissions including intensive care unit stay increased (32.4% in 2009 versus 66.1% in 2011;  $p < 0.001$ ), and the number of patients admitted to tertiary hospitals increased (47.0% versus 69.6%;  $p < 0.001$ ).

**Conclusion:** The AMI management system implantation increased the access of the population to proper treatment, thus reducing in-hospital mortality due to AMI. (Arq Bras Cardiol. 2013; [online].ahead print, PP.0-0)

**Keywords:** Myocardial infarction / mortality; Myocardial infarction / therapy; Emergency Medical Services; Intensive Care Units.

## Introduction

Over the past decades, an important reduction in the mortality rate of cardiovascular diseases has been observed, being related to advances in primary prevention and treatment of acute coronary syndrome (ACS)<sup>1-4</sup>. Although a world trend, that reduction has been more pronounced in developed countries, in which timely treatment is available, with reperfusion by use of primary angioplasty or fibrinolysis, dual antithrombotic therapy and critical care.

In Brazil, cardiovascular diseases remain the major cause of proportional mortality, and accounted for 29% of the deaths in 2010 (Department of Information Technology of the Brazilian

Unified Health Care System [Datusus]). Acute myocardial infarction (AMI) is the second most frequent cause of death (7%, Datusus 2010). In the Brazilian public health system, the in-hospital mortality due to AMI remains persistently elevated: on average, 16.2% in 2000, 16.1% in 2005, and 15.3% in 2010 for all admissions in the entire country (Datusus). The elevated mortality in the Brazilian public health system has been attributed to difficulties experienced by patients with AMI to have access to intensive care, reperfusion methods and the therapeutic measures established for AMI<sup>5</sup>.

Recognizing that the proper treatment of AMI requires the interaction of several sectors [community, prompt care units (PCUs), emergency transportation service, and hospital with a catheterization laboratory and intensive care unit] has induced the creation of AMI management systems to optimize patient's care, from early diagnosis to timely treatment<sup>6-9</sup>. Most experiences reported have been developed in North-American and European countries, while descriptions of experiences in developing countries, such as Brazil, are rare.

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This study aimed at implanting the AMI Management System in the municipality of Belo Horizonte, capital of the state of Minas Gerais, and at assessing its impact on in-hospital mortality due to AMI.

## Methods

This is a retrospective observational study carried out in the municipality of Belo Horizonte, whose population in 2009 was 2,452,617 inhabitants<sup>10</sup>.

The municipality of Belo Horizonte is organized in regionals, as shown in Figure 1. The Mobile Emergency Care Service (Samu) provides pre-hospital care for urgency and emergency cases and operates with 18 Basic Support Units (BSU) and 6 Advanced Support Units (ASU). The Medical Regulatory Centre is the coordinating and instructing element of the system, which organizes the relationship between the various services and qualifies its flow.

Each regional has a referral center for pre-hospital care, the PCU. In addition, there are urgent entry points to the hospital and tertiary hospitals specialized in cardiology (THC) spread throughout the municipality.

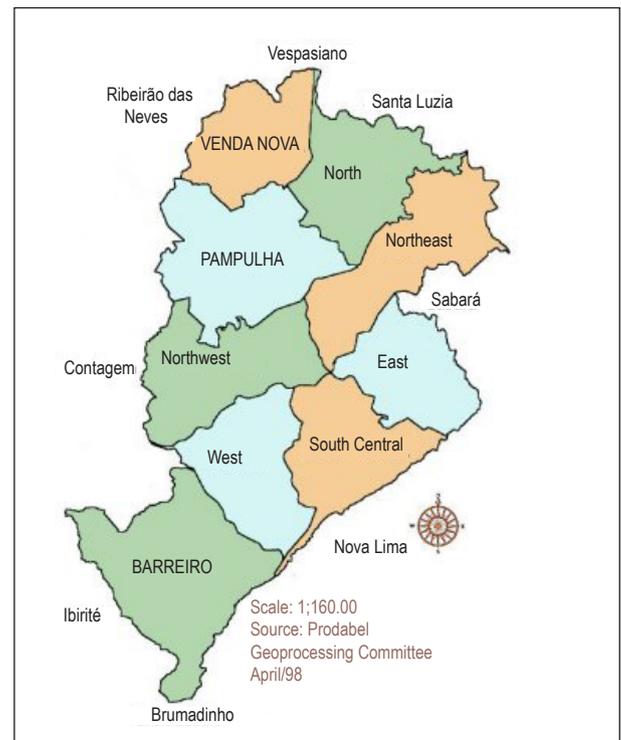
### Creation of the AMI management system in the municipality of Belo Horizonte

Aiming at increasing the access of patients of the Brazilian Unified Health Care System (SUS) to the treatment recommended in existing guidelines<sup>11-13</sup>, the Municipal Health Secretariat of Belo Horizonte (SMSA) established a flowchart for patients with ACS in need for emergency services in the municipality of Belo Horizonte, with the support of Samu and participation of the Hospital das Clínicas da UFMG (HC/UFMG), comprising the Telehealth Centre, the Cardiology and Cardiovascular Surgery Service, and the Hemodynamic Sector of that hospital. The HC/UFMG, a hospital with catheterization laboratory, opened a Coronary Unit (COU) in March 2010. In October 2011, the Hospital Santa Casa de Misericórdia began to integrate that flowchart, by making available its catheterization laboratory and COU beds. The objective of the COU is to ensure the timely acceptance, through transference, of patients with ACS admitted to emergency care units of the SUS-BH network and to provide, in addition to the treatment recommended by the guidelines for ACS and monitoring in an intensive care setting, access to primary and rescue percutaneous coronary intervention (PCI), when indicated. Patients with ACS can also be transferred to the THC of the SUS-BH network, which differs from the COU by not providing access to primary and rescue PCI (or urgency PCI).

#### Implantation of the tele-electrocardiology system

In the management of patients with ACS and ST-segment elevation, performing pre-hospital electrocardiography (ECG) in addition to the early activation of the catheterization laboratory represents an important strategy to reduce the door-to-balloon time, with a significant reduction in mortality<sup>14-19</sup>.

The implantation of the tele-electrocardiology system was an important component of the AMI management system. The tele-electrocardiology system was implanted by the Minas Gerais Telecare Service (Rede de Teleassistência de



**Figure 1** – Regionals of the municipality of Belo Horizonte. Each regional has one prompt care unit.

Minas Gerais - RTMG) with the support of the SMSA. The RTMG is a telecare service formed by a partnership between six universities of the state of Minas Gerais, and coordinated by the Telehealth Centre of the HC/UFMG<sup>20</sup>. That service began in 2005 and has performed more than 1,000,000 digital ECGs<sup>21</sup>.

Digital electrocardiographs were installed in seven PCUs, connected to computers. The analysis software was installed in the COUs. After performing the ECG, the exam can be transmitted to either COUs, if the case is an ACS with ST-segment elevation, or to the cardiology service of the RTMG, if an ECG report is required.

To ensure proper transmission, the quality of the signal emitted was tested in each PCU. The ECG transmission is immediate, via internet, and is identified at the COUs by the emission of a sound signal.

#### Training and motivating the teams

The following training and motivation strategies were developed for the PCU teams:

- visits to the PCUs to provide information about the operational flow and potential benefits of the implantation of the AMI management system;
- multidisciplinary training of the PCU teams regarding the approach of a patient with chest pain, ACS, and the use of the digital electrocardiograph (Figure 2);
- disclosure of the Clinical Protocol on ACS of the State Health Secretariat of Minas Gerais<sup>22</sup>;

- continued supervision by use of weekly telephone monitoring, in which the existence of problems in the digital ECG transmission or the need for new trainings are assessed. Technical problems are solved by the information technology team within 24 hours. Problems of infrastructure and internet are referred to the SMSA.

### Operational flow

Considering the patient's clinical context and the health care system, an operational flow for the AMI management system implantation was created (Figure 3).

When ACS with ST-segment elevation is suspected, the physician of the PCU initiates the first measures for ACS treatment<sup>11,12</sup> and performs digital ECG, which is sent to the COU. On the occasion, that PCU physician contacts the COU physician by use of a mobile phone. The latter assesses the ECG (Figure 4), and, if the diagnosis of ACS with ST-segment elevation is confirmed, the patient can follow either the rapid care path or the SMSA Admission Centre care path. At other emergency units with no digital ECG, the physician should call the COU to discuss the case.

When chest pain has initiated more than 3 hours and less than 12 hours before, or more than 12 hours before but is recurrent or refractory, or in the presence of cardiogenic shock, the patient should follow the rapid path, being referred by the Samu directly to the catheterization laboratory for primary angioplasty, reducing the delay for reperfusion. When chest pain has initiated less than 3 hours before, the PCU physician is instructed to administer the thrombolytic agent, except when contraindicated, and then to transfer the patient as soon as possible to the COU or THC. That transfer is regulated by the Admission Centre. However, when neither clinical (pain relief and hemodynamic stability) nor electrocardiographic (50% reduction in the ST-segment elevation in the lead with the greatest elevation, 90 minutes after initiating the thrombolytic agent)<sup>23</sup> reperfusion criteria are met after the thrombolytic infusion, the COU should be contacted again and the patient transferred via the rapid path for rescue angioplasty.

In the presence of ACS without ST-segment elevation, the patient is registered at the Admission Centre, which refers the patient to the COU or THC. Transference to the COU is preferential for patients at high or intermediate risk of adverse cardiovascular events, identified by the presence of high levels of myocardial necrosis markers or depression of the ST segment compatible with myocardial ischemia, or by the TIMI or GRACE risk scores<sup>13</sup>.

Aiming at the continued care of patients with ACS, ward beds and outpatient clinics for post-AMI care are provided to those patients for six-month follow-up, during which cardiovascular risk stratification is continued and secondary prevention of new events is performed. In addition, there is the opportunity of follow-up at a cardiovascular rehabilitation center or a smoke cessation outpatient clinic in certain cases<sup>24</sup>. After six months, the patient is referred for primary care or to a cardiologist of the SUS-BH health care network.

### Outcomes

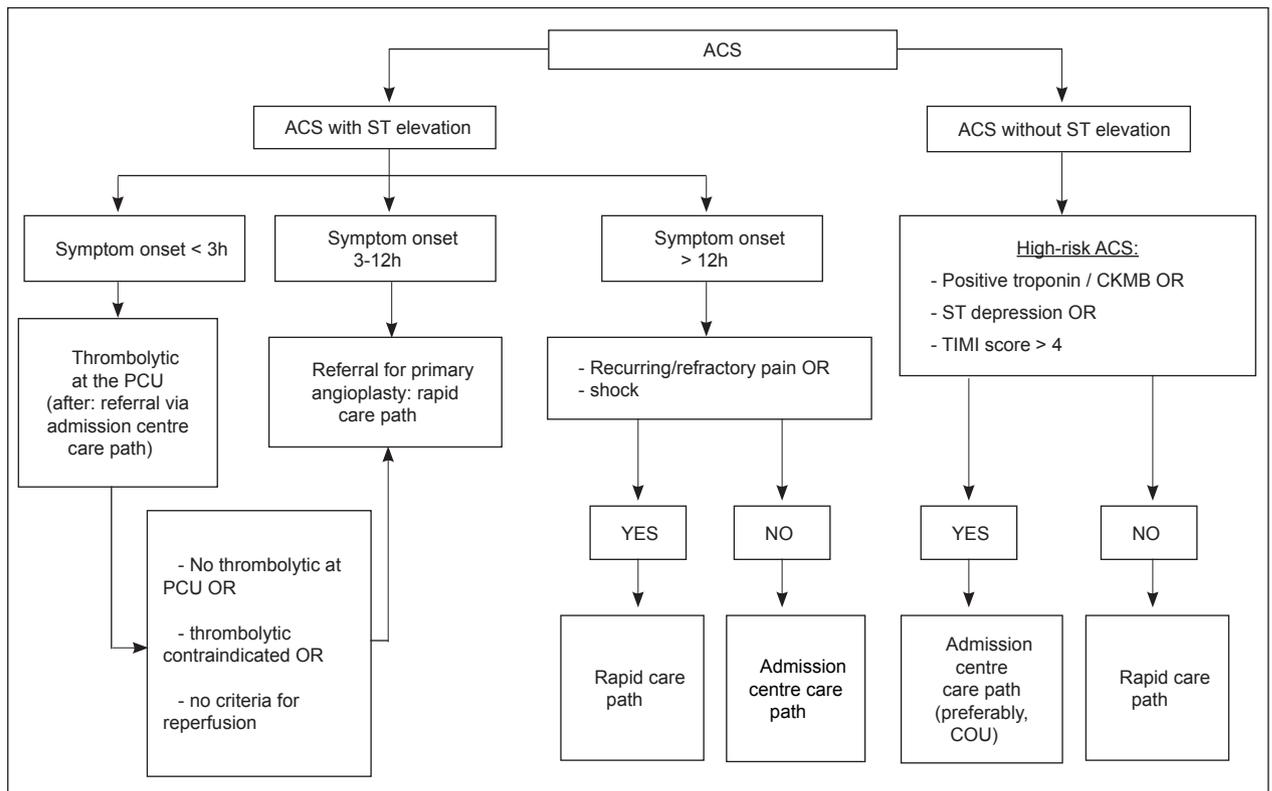
The outcomes assessed were the number of admissions due to AMI and in-hospital mortality due to AMI assessed from 2009 (baseline) to 2011. Data from the Hospital Information System (HIS) on the procedure Treatment of AMI, code SIH/DATASUS 03.03.06.019-0, were used. That procedure was considered the one that best represented the cases related to coronary events and that encompassed the most severe cases. The percentage of hospitalizations due to AMI involving intensive care unit (ICU) stay and the percentage of authorizations of hospital admission (AHAs) to THC have also been obtained from the HIS. The populations of the regionals for the years studied have also been obtained from Datasus.

### Statistical analysis

The epidemiological data generated by the HIS/Datasus were introduced in a data bank and analyzed by using the statistical package SPSS 20.0 (IBM Corporation, 2011). Qualitative variables were described by use of frequency



Figure 2 – Training of professionals of prompt care units to perform and transmit digital electrocardiograms



**Figure 3** – Operational flowchart for managing patients with acute coronary syndrome in the municipality of Belo Horizonte. ACS: acute coronary syndrome; CKMB: creatine phosphokinase MB fraction; COU: coronary units for the management of patients with ACS in the municipality of Belo Horizonte.

distribution, and quantitative variables, by use of mean and standard deviation or median and interquartile range. The proportions, means and medians of independent and dependent variables in the period assessed (2009 to 2011) and between the groups (AHAs with and without ICU cost per day) were compared by use of appropriate statistical tests,



**Figura 4** – Analysis of the digital electrocardiogram of a case of acute coronary syndrome with ST-segment elevation by the coronary unit physician.

including the chi-square, the Student *t*, and the Kruskal-Wallis tests. A *p* value  $\leq 0.05$  was considered statistically significant.

## Results

The tele-electrocardiology system was implanted in the first PCU in January 2011. From January to December 2011, 294 professionals were trained and 1,496 ECGs were transmitted as follows: 563 (37.6%) to COUs and 933 (62.4%) for report. A great variation in the number of ECGs per PCU was observed, and the Centro-sul (66.0%), Leste (12.0%) and Venda Nova (9.8%) PCUs performed more exams.

Table 1 shows the indicators selected from 2009 to 2011. Analyzing the temporal trend, the demographic characteristics were similar, with mean age around 60 years, and male sex predominance. The number of hospital admissions remained relatively stable over the period analyzed, ranging from 1,113 to 1,358. The mean hospital length of stay did not differ statistically over the years. However, the number of in-hospital deaths decreased, resulting in a significant reduction in the in-hospital mortality rate: from 12.3% in 2009 to 7.1% in 2011, reaching statistical significance ( $p < 0.001$ ).

In addition, the mean admission cost almost doubled during a time in which no significant readjustment in the prices of the SUS procedures occurred, which is an indirect indicator of greater access to the THC. There was an increase in the percentage of admissions including ICU stay (from 32.4% in 2009 to 66.1% in 2011,  $p < 0.001$ ) and in the proportion of

patients admitted to the THC of Belo Horizonte (from 47.0% to 69.6%,  $p < 0.001$ ).

Comparing the group of patients whose hospitalizations contemplated ICU stay with that whose hospitalizations did not contemplate ICU stay, higher mortality was observed in the former in 2009 (19.7% versus 8.8%,  $p < 0.001$ ) and in 2010 (12.6% versus 7.6%,  $p < 0.001$ ), but not in 2011 (7.8% versus 5.7%,  $p = 0.08$ ). Analyzing separately those patients who stayed at the ICU, a statistically significant reduction in the mean hospital length of stay was observed, from  $14.4 \pm 14.4$  days in 2009 to  $12.7 \pm 10.1$  days in 2011 ( $p = 0.022$ ), as well as an even more expressive reduction in mortality over the years than that of the entire sample, from 19.7% in 2009 to 12.6% in 2010 and 7.8% in 2011 ( $p < 0.001$ ).

## Discussion

The creation of the AMI management system has led to the reorganization of the care provided to patients suspected of having ACS in the municipality of Belo Horizonte. That system included training and motivating the PCU teams, in addition to a higher integration between the services, enabling access to catheterization laboratories and beds in the ICU and THC. Data from the HIS showed a reduction in the in-hospital mortality rate due to AMI based on the implantation of that management system with rates lower than those observed in the major Brazilian capitals.

Previous studies have shown that the high in-hospital mortality due to AMI in the Brazilian public health care system is associated with difficulties to access and low use of the treatment recommended for AMI, such as reperfusion therapy, drugs and ICU facilities<sup>5</sup>. Thus, Evangelista et al<sup>25</sup>, studying SUS patients diagnosed with AMI in the municipality of Belo Horizonte in 2002 and 2003, have reported that only 33% of them had been admitted to the ICU during their hospitalization. In addition, having been admitted to a public hospital (as opposed to hospitals of the private health care system) was an independent factor of poor prognosis. A study carried out in Feira de Santana, state of Bahia, has reported a 19.5% mortality in patients with AMI admitted to a public hospital of that municipality, four times greater than that found in patients admitted to three private hospitals in that same municipality (4.8%,  $p = 0.001$ )<sup>26</sup>. Among the patients admitted to the public hospital, poor and illiterate ones predominated, took longer to arrive at the hospital and to be medicated, progressing to greater disease severity, manifested as the high frequency of patients with Killip class II or over. Only 8% of the patients of the public hospital were admitted to the ICU, and 21% underwent reperfusion therapy; 94% of the patients of the private health care system were admitted to the ICU, thrombolytic agents being used in 79% of them. Beta-blockers, independent predictors of prognosis in this sample, have also been more frequently used in private hospitals<sup>26</sup>.

Data regarding hospitalizations due to AMI in the municipality of Belo Horizonte in the period studied showed a tendency towards greater access of the population to high-complexity treatment after the implantation of the AMI management system. That tendency can be inferred based on indirect data, such as the increase in the mean cost of

hospitalization, which is primarily due to the greater access to tertiary hospitals, and, thus, to ICU beds. The greater access to high-complexity treatment is demonstrated by direct data, with a statistically significant increase in the AHAs to that type of hospitals and in the percentage of ICU cost per day. By ensuring a greater access to those resources, the possibility of performing complementary tests of fundamental importance in the management of the acute phase of ACS, such as echocardiography, treadmill test and nuclear medicine tests, is increased. In addition, the access to cardiac catheterization and PCI, which have impact on in-hospital and late adverse events, is increased<sup>27-32</sup>.

Furthermore, the implantation of clinical protocols on the management of AMI, based on scientific evidence, is related to an improvement in the indicators of morbidity and mortality<sup>33,34</sup>. The Clinical Protocol on ACS of the State Health Secretariat of Minas Gerais<sup>22</sup> was developed with the participation of professionals of the HC/UFMG, also involved with the implantation of the AMI management system in the municipality of Belo Horizonte and the training of the urgency and emergency teams. Knowing the local conditions for the application of the international guidelines is essential. Thus, when elaborating the flowchart, we chose to administer the thrombolytic agent at the PCU to patients with chest pain for less than 3 hours, because the shorter the ischemia duration, the more effective the thrombolytic therapy; primary PCI would benefit those patients only if their referral occurred within the first 60 minutes<sup>35,36</sup>, which cannot be accomplished within the transference system of the municipality of Belo Horizonte. The target delay time of that system is of up to 120 minutes, and the maximum target door-to-balloon time at the hospital with catheterization laboratory is 90 minutes<sup>11,35,36</sup>. It is worth emphasizing the option of direct case discussion, involving physicians at PCUs and general hospitals and specialists at COUs, providing greater safety to the assistant physician and improving referrals.

The implantation of the tele-electrocardiology system is an important component of the AMI management system in the municipality of Belo Horizonte, because it more quickly directs the transference of patients diagnosed with ACS with ST-segment elevation to the COU. A reduction in the door-to-balloon time and mortality has been evidenced with the use of pre-hospital ECG as a component of the AMI management system<sup>37</sup>.

The results of the present study suggest that the AMI management system implantation had a positive impact on the overall in-hospital mortality rates due to AMI after 2009. However, there are limitations regarding that analysis. This was an observational study, using secondary data derived from the AHAs issued in the period studied and dependent on data accuracy, from the primary care network to the in-hospital information flow. In addition, only one of the clinical SUS procedures was selected; there were at least two more clinical procedures, in addition to the codes related to the interventions (percutaneous and surgical), which were not selected because of the information bias that could be generated. For example, we can cite patients with ACS who ended up undergoing coronary angioplasty: in that case, with the change in the procedure, the patient passes to be in the

**Table 1 – Number of hospitalizations due to AMI, demographic variables and indicators related to access to treatment of AMI in the municipality of Belo Horizonte, from 2009 to 2011**

Indicator	2009	2010	2011	Value p
Number of hospitalizations	1242	1113	1358	NA
Sex (% male)	63.3	63.9	62.0	0.609
Age (mean ± SD)	60.7 ± 13.0	60.4 ± 12.9	60.2 ± 13.0	0.528
Length of stay (days; mean ± SD)	12.9 ± 11.8	12.3 ± 9.9	12.5 ± 10.9	0.186
Mean hospitalization cost (R\$; mean ± SD)	2480 ± 4054	2569 ± 3222	3501 ± 3202	< 0.001
Hospitalizations including ICU stay (n / %)	402/32.4	453/40.7	898/66.1	< 0.001
Proportion of AMI admitted to tertiary hospitals (%)	584/47.0	641/57.6	945/69.6	< 0.001
In-hospital mortality due to AMI (n/%)	153/12.3	107/9.6	96/7.1	< 0.001

SD: standard deviation; ICU: intensive care unit; AMI: acute myocardial infarction; NA: not assessed.

system only among the cases of angioplasty and no longer among those with AMI. Angioplasty, however, could not be used in this analysis because it also encompasses outpatient elective procedures.

Another limitation is the fact that this study assessed only in-hospital mortality. Some patients with AMI die before hospital admission. Assessing out-of-hospital mortality is extremely important, because it also reflects access to treatment. Difficulties of access tend to increase the time to admission, decreasing the in-hospital lethality expected and increasing the out-of-hospital mortality.

However, despite those limitations, the missed data might relate to the subgroup of patients who benefited most from the network and access to high-complexity interventions, suggesting that the benefit might be even greater than that recorded. The mortality rates by the end of the AMI management system implantation are lower than the mean reported in a study on the Brazilian reality<sup>26</sup> and those obtained directly from the HIS/Datasus.

Experiences on the organization of AMI care in other Brazilian cities have been reported<sup>38,39</sup>. All of them have been based, at least partially, on the observation that the

organization of AMI management systems in other countries can significantly reduce mortality and morbidity due to AMI<sup>40</sup>. The importance of organizing the AMI care has been recognized by the Brazilian Ministry of Health, with the enactment, in December 2011, of an ordinance that regulates the implantation of AMI management systems in Brazil, aiming at reducing the mortality due to AMI in the entire country. Reporting the experience in the municipality of Belo Horizonte is important to support the debate on such actions that can effectively reduce the burden of AMI in Brazil.

#### Potential Conflict of Interest

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

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There were no external funding sources for this study.

#### Study Association

This study is not associated with any post-graduation program.

## References

- Schmidt M, Jacobsen JB, Lash TL, Botker HE, Sorensen HT. 25 year trends in first time hospitalisation for acute myocardial infarction, subsequent short and long term mortality, and the prognostic impact of sex and comorbidity: a Danish nationwide cohort study. *BMJ*. 2012;344:e356.
- Orozco-Beltran D, Cooper RS, Gil-Guillen V, Bertomeu-Martinez V, Pita-Fernandez S, Durazo-Arvizu R, et al. Trends in mortality from myocardial infarction: a comparative study between Spain and the United States: 1990-2006. *Rev Esp Cardiol*. 2012;65(12):1079-85.
- Movahed MR, John J, Hashemzadeh M. Mortality trends for non-ST-segment elevation myocardial infarction (NSTEMI) in the United States from 1988 to 2004. *Clin Cardiol*. 2011;34(11):689-92.
- Ford ES, Ajani UA, Croft JB, Critchley JA, Labarthe DR, Kottke TE, et al. Explaining the decrease in U.S. deaths from coronary disease, 1980-2000. *N Engl J Med*. 2007;356(23):2388-98.
- Ribeiro AL. The two Brazils and the treatment of acute myocardial infarction. *Arq Bras Cardiol*. 2009;93(2):83-4.
- Henry TD, Gibson CM, Pinto DS. Moving toward improved care for the patient with ST-elevation myocardial infarction: a mandate for systems of care. *Circ Cardiovasc Qual Outcomes*. 2010;3(5):441-3.
- Jacobs AK, Antman EM, Faxon DP, Gregory T, Solis P. Development of systems of care for ST-elevation myocardial infarction patients: executive summary. *Circulation*. 2007;116(2):217-30.
- Jollis JG, Granger CB, Henry TD, Antman EM, Berger PB, Moyer PH, et al. Systems of care for ST-segment-elevation myocardial infarction: a report from the American Heart Association's Mission: Lifeline. *Circ Cardiovasc Qual Outcomes*. 2012;5(4):423-8.
- Ting HH, Rihal CS, Gersh BJ, Haro LH, Bjerke CM, Lennon RJ, et al. Regional systems of care to optimize timeliness of reperfusion therapy for ST-elevation myocardial infarction: the Mayo Clinic STEMI Protocol. *Circulation*. 2007;116(7):729-36.
- Instituto Brasileiro de Geografia e Estatística (IBGE). Estimativas populacionais para o TCU. [Acesso em 2012 maio 28]. Disponível em <http://www.datasus.gov.br>.
- Piegas LS, Feitosa G, Mattos LA, Nicolau JC, Rossi-Neto JM, A T. Diretriz da Sociedade Brasileira de Cardiologia sobre tratamento do infarto agudo do miocárdio com supradesnível de ST. *Arq Bras Cardiol*. 2009;93(6 supl 2):e179-e264.
- Kushner FG, Hand M, Smith SC Jr, King SB 3rd, Anderson JL, Antman EM, et al. 2009 Focused Updates: ACC/AHA Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction (updating the 2004 Guideline and 2007 Focused Update) and ACC/AHA/SCAI Guidelines on Percutaneous Coronary Intervention (updating the 2005 Guideline and 2007 Focused Update): a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2009;120(22):2271-306.
- Anderson JL, Adams CD, Antman EM, Bridges CR, Califf RM, Casey Jr DE, et al. ACC/AHA 2007 Guidelines for the Management of Patients With Unstable Angina/Non-ST-Elevation Myocardial Infarction: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines for the Management of Patients With Unstable Angina/Non-ST-Elevation Myocardial Infarction) Developed in Collaboration with the American College of Emergency Physicians, the Society for Cardiovascular Angiography and Interventions, and the Society of Thoracic Surgeons Endorsed by the American Association of Cardiovascular and Pulmonary Rehabilitation and the Society for Academic Emergency Medicine. *J Am Coll Cardiol*. 2007;50(7):e1-e157.
- Carstensen S, Nelson GC, Hansen PS, Macken L, Irons S, Flynn M, et al. Field triage to primary angioplasty combined with emergency department bypass reduces treatment delays and is associated with improved outcome. *Eur Heart J*. 2007;28(19):2313-9.
- Clemmensen P, Sejersten M, Sillesen M, Hampton D, Wagner GS, Loumann-Nielsen S. Diversion of ST-elevation myocardial infarction patients for primary angioplasty based on wireless prehospital 12-lead electrocardiographic transmission directly to the cardiologist's handheld computer: a progress report. *J Electrocardiol*. 2005;38(4 Suppl):194-8.
- Curtis JP, Portnay EL, Wang Y, McNamara RL, Herrin J, Bradley EH, et al. The pre-hospital electrocardiogram and time to reperfusion in patients with acute myocardial infarction, 2000-2002: findings from the National Registry of Myocardial Infarction-4. *J Am Coll Cardiol*. 2006;47(8):1544-52.
- Diercks DB, Kontos MC, Chen AY, Pollack CV, Jr., Wiviott SD, Rumsfeld JS, et al. Utilization and impact of pre-hospital electrocardiograms for patients with acute ST-segment elevation myocardial infarction: data from the NCDR (National Cardiovascular Data Registry) ACTION (Acute Coronary Treatment and Intervention Outcomes Network) Registry. *J Am Coll Cardiol*. 2009;53(2):161-6.
- Gross BW, Dauterman KW, Moran MG, Kotler TS, Schnugg SJ, Rostykus PS, et al. An approach to shorten time to infarct artery patency in patients with ST-segment elevation myocardial infarction. *Am J Cardiol*. 2007;99(10):1360-3.
- Pedersen SH, Galatius S, Hansen PR, Mogelvang R, Abildstrom SZ, Sorensen R, et al. Field triage reduces treatment delay and improves long-term clinical outcome in patients with acute ST-segment elevation myocardial infarction treated with primary percutaneous coronary intervention. *J Am Coll Cardiol*. 2009;54(24):2296-302.
- Ribeiro AL, Alkmim MB, Cardoso CS, Carvalho GG, Caiiffa WT, Andrade MV, et al. Implementation of a telecardiology system in the state of Minas Gerais: the Minas Telecardio Project. *Arq Bras Cardiol*. 2010;95(1):70-8.
- Alkmim MB, Figueira RM, Marcolino MS, Cardoso CS, Pena de Abreu M, Cunha LR, et al. Improving patient access to specialized health care: the Telehealth Network of Minas Gerais, Brazil. *Bull World Health Organ*. 2012;90(5):373-8.
- Junqueira LL, Ribeiro AL, Mafra AA. Secretaria de Estado de Saúde de Minas Gerais. Síndrome coronariana aguda (protocolo clínico). [Acesso em 2012 dez 10]. Disponível em <http://www.saude.mg.gov.br/protocolosclinicos>.
- Antman EM, Hand M, Armstrong PW, Bates ER, Green LA, Halasyamani LK, et al. 2007 Focused Update of the ACC/AHA 2004 Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines: developed in collaboration With the Canadian Cardiovascular Society endorsed by the American Academy of Family Physicians: 2007 Writing Group to Review New Evidence and Update the ACC/AHA 2004 Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction, Writing on Behalf of the 2004 Writing Committee. *Circulation*. 2008;117(2):296-329.
- Krumholz HM, Anderson JL, Bachelder BL, Fesmire FM, Fihn SD, Foody JM, et al. ACC/AHA 2008 performance measures for adults with ST-elevation and non-ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Performance Measures (Writing Committee to Develop Performance Measures for ST-Elevation and Non-ST-Elevation Myocardial Infarction) Developed in Collaboration With the American Academy of Family Physicians and American College of Emergency Physicians Endorsed by the American Association of Cardiovascular and Pulmonary Rehabilitation, Society for Cardiovascular Angiography and Interventions, and Society of Hospital Medicine. *J Am Coll Cardiol*. 2008;52(24):2046-99.
- Evangelista PA, Barreto SM, Guerra HL. Hospital admission and hospital death associated to ischemic heart diseases at the National Health System (SUS). *Arq Bras Cardiol*. 2008;90(2):119-26.
- Ferreira GM, Correia LC, Reis H, Ferreira Filho CB, Freitas F, Junior I, et al. Increased mortality and morbidity due to acute myocardial infarction in a public hospital, in Feira de Santana, Bahia. *Arq Bras Cardiol*. 2009;93(2):97-104.
- Hirsch A, Windhausen F, Tijssen JG, Verheugt FW, Cornel JH, de Winter RJ. Long-term outcome after an early invasive versus selective invasive treatment

- strategy in patients with non-ST-elevation acute coronary syndrome and elevated cardiac troponin T (the ICTUS trial): a follow-up study. *Lancet*. 2007;369(9564):827-35.
28. Lagerqvist B, Husted S, Kontny F, Stahle E, Swahn E, Wallentin L. 5-year outcomes in the FRISC-II randomised trial of an invasive versus a non-invasive strategy in non-ST-elevation acute coronary syndrome: a follow-up study. *Lancet*. 2006;368(9540):998-1004.
  29. Fox KA, Poole-Wilson P, Clayton TC, Henderson RA, Shaw TR, Wheatley DJ, et al. 5-year outcome of an interventional strategy in non-ST-elevation acute coronary syndrome: the British Heart Foundation RITA 3 randomised trial. *Lancet*. 2005;366(9489):914-20.
  30. Mehta SR, Cannon CP, Fox KA, Wallentin L, Boden WE, Spacek R, et al. Routine vs selective invasive strategies in patients with acute coronary syndromes: a collaborative meta-analysis of randomized trials. *JAMA*. 2005;293(23):2908-17.
  31. Di Mario C, Dudek D, Piscione F, Mielecki W, Savonitto S, Murena E, et al. Immediate angioplasty versus standard therapy with rescue angioplasty after thrombolysis in the Combined Abciximab REteplase Stent Study in Acute Myocardial Infarction (CARESS-in-AMI): an open, prospective, randomised, multicentre trial. *Lancet*. 2008;371(9612):559-68.
  32. Cantor WJ, Fitchett D, Borgundvaag B, Ducas J, Heffernan M, Cohen EA, et al. Routine early angioplasty after fibrinolysis for acute myocardial infarction. *N Engl J Med*. 2009;360(26):2705-18.
  33. Peterson ED, Roe MT, Mulgund J, DeLong ER, Lytle BL, Brindis RG, et al. Association between hospital process performance and outcomes among patients with acute coronary syndromes. *JAMA*. 2006;295(16):1912-20.
  34. Polanczyk CA, Biolo A, Imhof BV, Furtado M, Alboim C, Santos C, et al. Improvement in clinical outcomes in acute coronary syndromes after the implementation of a critical pathway. *Crit Pathw Cardiol*. 2003;2(4):222-30.
  35. Pinto DS, Frederick PD, Chakrabarti AK, Kirtane AJ, Ullman E, Dejam A, et al. Benefit of transferring ST-segment-elevation myocardial infarction patients for percutaneous coronary intervention compared with administration of onsite fibrinolytic declines as delays increase. *Circulation*. 2011;124(23):2512-21.
  36. Ting HH, Yang EH, Rihal CS. Narrative review: reperfusion strategies for ST-segment elevation myocardial infarction. *Ann Intern Med*. 2006;145(8):610-7.
  37. Ortolani P, Marzocchi A, Marrozzini C, Palmerini T, Saia F, Taglieri N, et al. Pre-hospital ECG in patients undergoing primary percutaneous interventions within an integrated system of care: reperfusion times and long-term survival benefits. *EuroIntervention*. 2011;7(4):449-57.
  38. Gonçalves-Junior I, Caluza AC, Barbosa AH, Oliveira CA, Amaral AZ, Zeefried CR, et al. Diminuição da mortalidade em infarto agudo do miocárdio com supra de ST na cidade de SP: efeitos da organização de uma rede de diagnóstico e terapêutica: análise de 171 casos. *Arq Bras Cardiol*. 2011;97(3 supl. 1):64.
  39. Solla DJF, Carvalho ME, Martins MS, Neto OM, Filho PRF, Roriz PS, et al. Implantação de redes regionais integradas de atendimento ao Infarto Agudo do Miocárdio no Brasil: a experiência de Salvador, Bahia. 66o Congresso Brasileiro de Cardiologia; Porto Alegre: Arq Bras Cardiol. 2011;97(3 supl. 1):85.
  40. Saia F, Marrozzini C, Guastaroba P, Ortolani P, Palmerini T, Pavesi PC, et al. Lower long-term mortality within a regional system of care for ST-elevation myocardial infarction. *Acute Card Care*. 2010;12(2):42-50.