

ORIGINAL RESEARCH

# Impact of a Preexisting STEMI Network in Improving STEMI Diagnostic and Treatment in the Community after the Introduction of a National Program of Interventional Treatment in Acute Myocardial Infarction

Marius Orzan, Theodora Benedek, Balázs Bajka, Kinga Pál, Nora Rat, Imre Benedek

University of Medicine and Pharmacy of Tîrgu Mureş, Clinic of Cardiology, Tîrgu Mureş, Romania

## ABSTRACT

**Introduction:** According to European guidelines, ST elevation acute myocardial infarction should be treated by immediate reperfusion, if diagnosed within 12 hours from the onset of symptoms. We aimed to show the impact of a well-functioning pre-existing STEMI network in improving the results of a national program dedicated to the invasive treatment of AMI.

**Methods:** We followed the comparison between primary PCI rates and STEMI-related mortality in two regions, after the introduction of a nationwide program for the interventional treatment of acute myocardial infarction: region A, where the territory has been appropriately prepared via previous organizational measures in the network, and region B, where the territory has not been previously prepared.

**Results:** In 2011, one year after the initiation of the national program, a primary PCI rate of 12.1%, a thrombolysis rate of 10.1% and a no-reperfusion treatment rate of 77.8% have been found in these new centers for patients arriving <12 h from symptoms onset. This has been reflected in a mortality of 23.07% for "early presentations" in these new centers in 2011. In comparison, data from the territorial hospitals of the registry (only those without cathlab facilities, similar to the new centers) showed in 2011 a 73.85% primary PCI rate, 12.09% thrombolysis rate and a 14.07% conservative treatment rate, reflected in a mortality of 6.81% for "early presentations" in the registry centers.

**Conclusions:** The national strategy for reduction of STEMI related mortality via implementation of primary PCI, started in 2010, had a significant impact especially in that region where the territory was previously prepared with appropriate organizational efforts, including educational and logistic measures.

**Keywords:** acute myocardial infarction, STEMI network, reperfusion

## CORRESPONDENCE

**Nora Rat**

University of Medicine and Pharmacy of Tîrgu Mureş, Clinic of Cardiology  
50 Gheorghe Marinescu St, Tîrgu Mureş, Romania

Tel/Fax: +40-265-211595

Email: ratnora@yahoo.com

## INTRODUCTION

According to European guidelines, ST elevation acute myocardial infarction should be treated by immediate reperfusion, if diagnosed within 12 hours from the onset of

symptoms [1,2,3,4]. The reperfusion strategy should be immediate transport followed by primary PCI if possible, and in absence of rapid access to a cardiac catheterization laboratory thrombolysis is the alternative of choice [5,6,7,8,9].

In order to evaluate the situation of STEMI treatment in our region, a preliminary study run in 2004 in a community of approx. 1 million people from Mureș county and the surrounding area indicated very low rates (10%) for primary PCI in the community.

To improve the situation of STEMI diagnosis and treatment [10,11], a regional STEMI network has been developed since 2004 in this community and in 2010 a national program for interventional treatment of acute myocardial infarction has been initiated.

This study aims to show the impact of a well-functioning pre-existing STEMI network in improving the results of a national program dedicated to the invasive treatment of AMI, comparing STEMI diagnostic, pPCI and mortality rates between previously network-prepared regions versus other regions where the territory has not been properly prepared via such a network.

## METHODS

A regional STEMI network has been introduced in 2004 consisting in a central base (academic hospital), which served as a pPCI center, and 13 territorial hospitals.

In order to increase the number of diagnosed STEMI and of patients referred for pPCI, organizational activities have been performed by the medical team of the primary PCI center, such as organization of educational meetings or implementation of troponin determination.

At the time of network initiation in 2004, there was no sufficient staff available in the academic center to assure a non-stop intervention for STEMI cases and availability of trained pPCI operators was based on an on-call strategy and activation of a local protocol, similar to other international STEMI protocols [12,13,14]. Starting with 2006, a continuous on-duty line was available in the primary PCI center, with 6 trained pPCI operators.

## STUDY ENDPOINTS

– **Primary endpoint** — we followed the comparison between primary PCI rates and STEMI-related mortality in two regions, after the introduction of a nationwide program for the interventional treatment of acute myocardial infarction:

- region A — where the territory has been appropriately prepared via previous organizational measures in the network;
- region B — not included in the STEMI network, therefore a region where the territory has not been previously prepared.

– **Secondary endpoint** — we followed the trend of the number of STEMI diagnosed cases, pPCI numbers and type of presentation within the recommended time-frame of 12 hours from the onset of symptoms in the community, from 2004 to 2011.

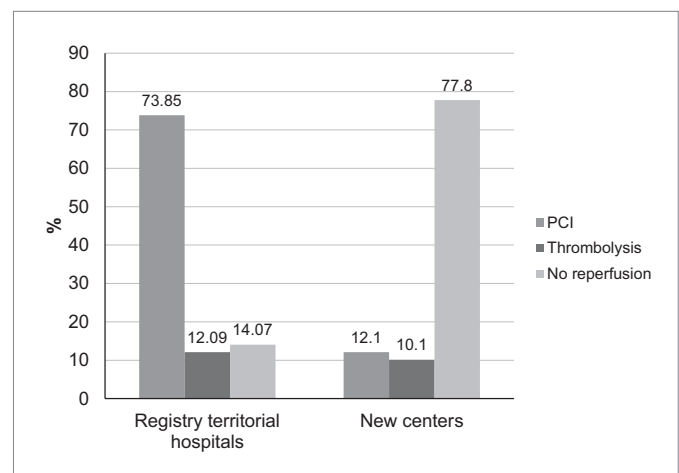
## RESULTS

### PPCI RATES AND STEMI-RELATED MORTALITY IN STEMI NETWORK VERSUS NEW CENTERS

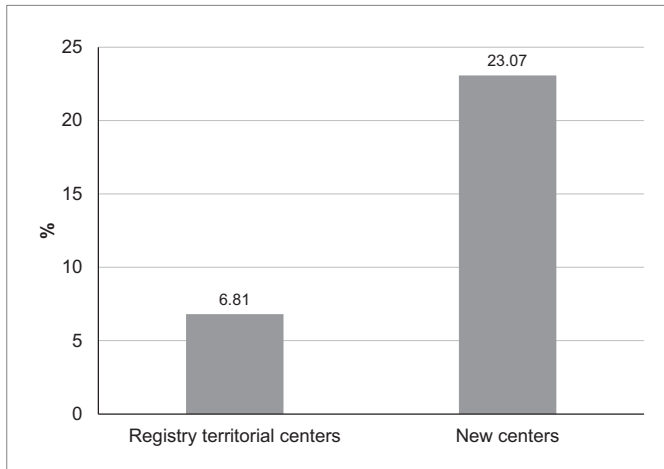
In order to underline the role of educational activities in the network, a separate analysis included mortality rates and primary PCI rates in 2011 in several centers from Romania, close to the registry network, but not included in this network, versus network centers.

In 2011, one year after the initiation of the national program, a primary PCI rate of 12.1%, a thrombolysis rate of 10.1% and a no-reperfusion treatment rate of 77.8% have been found in these new centers for patients arriving <12 h from symptoms onset. This has been reflected in a mortality of 23.07% for "early presentations" in these new centers in 2011. In comparison, data from the territorial hospitals of the registry (only those without cathlab facilities, similarly to the new centers) showed in 2011 a 73.85% primary PCI rate, a 12.09% thrombolysis rate and a 14.07% conservative treatment rate, reflected in a mortality of 6.81% for "early presentations" in the registry centers (Figures 1 and 2).

Data of the new centers are approximately similar with those recorded in the territorial hospitals from the regis-



**FIGURE 1.** Treatment strategy in territorial centers from the registry versus new centers in the national program for patients presenting <12 h from symptoms onset – 2011

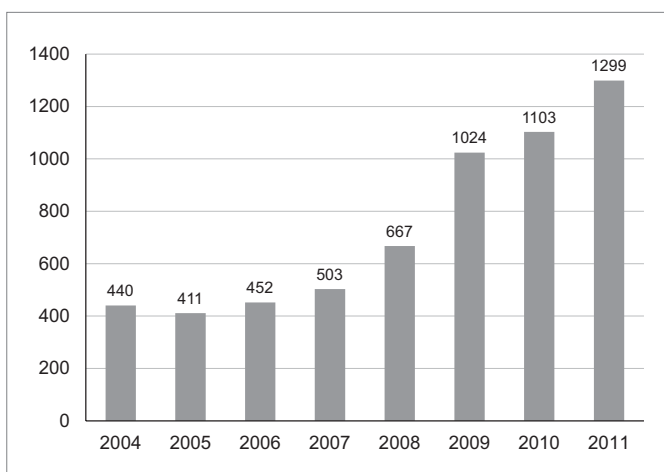


**FIGURE 2.** Mortality in territorial centers from the registry versus new centers in the national program for patients presenting <12 h from symptoms onset – 2011

try in 2006, when the rate of reperfusion treatment was 18.13% and mortality was 19.46% in patients presenting <12 h from symptoms onset.

### EVOLUTION OF THE NUMBER OF STEMI CASES

As a result of an increasing capacity to diagnose STEMI cases, the total number of STEMI cases enrolled in the registry has been increasing continuously after the first 3 years — from 440 STEMI/year diagnosed in 2004, 411 in 2005 and 452 in 2006, to 503 in 2007, 667 in 2008, 1024 in 2009, 1103 in 2010 and 1,299 STEMI cases diagnosed in 2011. This represents a 2.95-fold increase in the number of STEMI cases/year from 2004 to 2011 (Figure 3).



**FIGURE 3.** Evolution of the number of STEMI cases

### TYPE OF PRESENTATION

Only 48.14% of the total population of the registry presented to the hospital in the first 12 hours after symptoms onset.

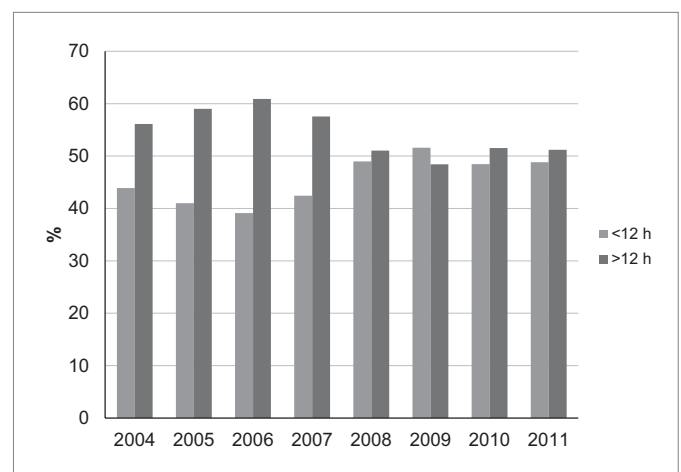
The rate of presentations <12 h from symptoms onset during the 8 years of the registry increased from 43.88% in 2004 to 48.82% in 2011 in the territorial hospitals (Figure 4), while in the PCI center, from a rate of 40.74% STEMI patients presented in time (<12 h) in 2004, the percentage of presentations <12h reached 62.28% in 2011.

A separate analysis of the PCI center data, after excluding the cases sent from the territory via emergency system and arrived <12h (which represent the majority of presentations <12 h in 2011), and considering only direct presentations to the academic hospital (direct transport with the ambulance from patient home to the hospital or spontaneous presentation to the emergency room), shows a rate of only 52.04% for presentations <12 h from symptoms onset for patients with STEMI in a large, academic city in 2011 (Figure 5).

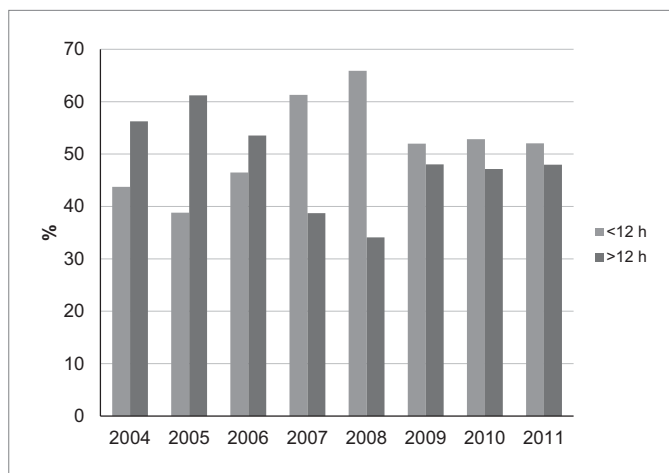
In the territorial hospitals in 2004 only 43.88% of STEMI patients presented to the hospitals in the first 12 hours from symptoms onset, with a slight improvement to 48.82% in 2011. In the academic center only 40.74% of STEMI patients presented before <12 h from symptoms onset to the hospital in 2004, while in 2011 a rate of early presentation of 62.28% has been achieved.

### PRIMARY PCI NUMBERS

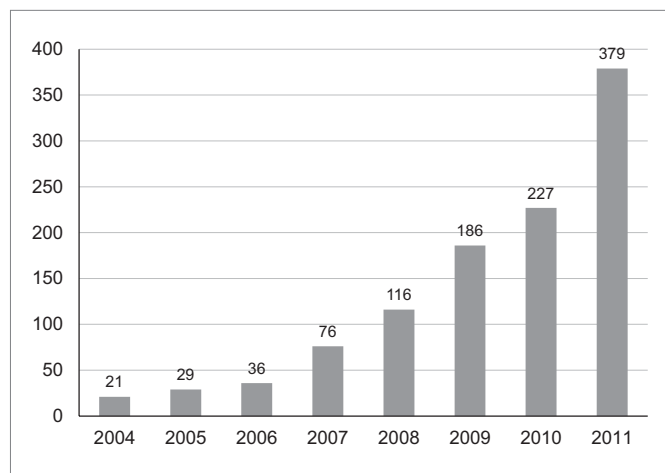
A total number of 1,070 primary PCIs have been performed from the beginning of the registry in the pPCI center representing the central base of the STEMI network. Primary



**FIGURE 4.** Presentation time in the territorial hospitals



**FIGURE 5.** Presentation time in the PCI centre – direct presentations

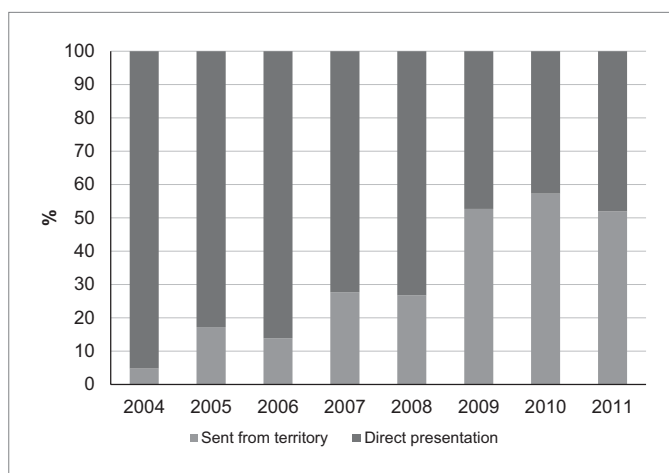


**FIGURE 6.** Evolution of primary PCI number in the central base of the registry

PCI number in the PCI center increased from 21 in 2004 to 379 in 2011, with the most significant increase in 2009 (increase of 60.34% compared with the previous year) — Figure 6.

Adding to these figures those pPCI performed in the secondary pPCI center in the last years, we reached a number of 1,451 pPCI for the whole duration of the study in both PCI centers.

At the beginning of the registry in 2004, from the total number of primary PCIs in the central unit of the registry, 95.24% were represented by direct presentations to the PCI hospital and only 4.76% have been sent from the territorial hospitals, while in 2011 51.98% of primary PCI cases arrived from the territorial hospitals (Figure 7).



**FIGURE 7.** Type of presentation in the primary PCI centre

## DISCUSSIONS

The number of STEMI patients recorded in the registry in 2004 (440) was inferior to the European average of 800 STEMI per million people [15,16]. Considering that Romania, due to social and nutritional factors, is the country with the highest cardiovascular morbidity and mortality in Europe, it is expected that the number of STEMI cases would be even higher than the European average. The low number of STEMI cases recorded in 2004 shows that an unacceptably high number of STEMI cases remained undiagnosed or not reported at that time. After intense organizational efforts, the situation has been changed during the eight years covered by this study, reaching a number of 1.146 STEMI per 1 million people in 2011, higher than the European average. This could be explained by higher cardiovascular morbidity and presence of risk factors in Romania compared with other European countries. Another national registry from Romania (Ro-STEMI registry) reported a lower number of 450 STEMI/1 million people in 2009 in Romania [17], compared with 965 STEMI/million in 2009 in our data. The difference between the two registries could be explained by the fact that the Ro-STEMI registry covered only main, selected hospitals and not the entire country, while this regional registry counted the STEMI cases from all the hospitals, large and small, in the studied territory, including a significant number of cases which remained in the small territorial hospitals and were not sent to a main hospital. Also, by 2009 we had already been conducting intensive educational work in the territorial hospitals for five years, which led to a superior capacity to accurately diagnose STEMI cases in this regional registry.

The percentage of 78.64% primary PCI achieved in our registry in 2011, which could be considered good compared with other European countries, is not representative for all Romania, only for the regional registry of the network. A rate of primary PCI of 5% has been reported by Romania in 2009 [17], which is very low compared to the 56.71% pPCI rate in this registry in 2009. One of the causes could be that this registry included only 4.5% from the total population of Romania, from a geographical area considered as having one of the highest level of education in the country for historical reasons, and the STEMI network in this registry was the only one in Romania at that time.

This registry does not include any data related to those who died at home, did not present to the hospital, were not diagnosed accurately in the hospital or presented to the hospital after 1 week from symptoms onset. The GRACE registry showed a higher mortality for STEMI patients presenting without chest pain [18], and probably such patients remained undiagnosed in this study.

The proper organization of the network has been reflected in a substantial increase in the number of patients diagnosed and treated for STEMI, in parallel with an increase in the number of patients presenting within the recommended timeframe of 12 hours, as a result of intensive educational activities in the network.

A significant and continuous increase in the number of STEMI cases was encountered during the 8 years of the registry. From 440 STEMI cases/year diagnosed in 2004, a number of 1.299 STEMI cases/year diagnosed was reached in 2011, which represents a 2.95-fold increase in the total number of STEMI cases. As the amount of population in the territory covered by the registry (circa 1 million people), as well as the global cardiovascular risk in this population [19] remained unchanged during these years, the only possible explanation for this significant increase in STEMI cases could be represented by the increase of ability to diagnose and report acute myocardial infarction cases, as a result of intensive educational activities organized in the registry network.

Primary PCI numbers have been continuously increasing from 21 cases in 2004 to 508 cases in 2011, with the most significant increase in 2009.

A sub-analysis of early versus late presentations in the territorial hospitals and in the academic hospital has been performed in this study, considering the differences in education and culture of the two populations (predominantly rural or from small cities in the territorial hospitals versus population of a large city with academic environment in the primary PCI center) [20].

These data show that despite a superior organization of the emergency system in 2011, which led to quicker diagnosis, higher PCI referral rates and shorter transportation times to the PCI center, there continues to exist a lack of adequate educational measures addressed to the population in order to make them aware about the symptoms and the risks of AMI, which leads to an unacceptable high number (almost 50%) of patients who call the emergency system or present to the hospital only after many hours from symptoms onset.

Intervention of the state via a national program for interventional treatment of Acute Myocardial Infarction happened in 2010 and consisted in the initiation of a new legislation, introducing the concept of mandatory reperfusion strategy in the first two hours and a dedicated budget for primary PCI. This intervention led to a further increase in primary PCI rates from 63.72% in 2010 to 78.64% in 2011 in the registry network, which is again reflected in a lower global mortality rate of 6.35% in 2011 for presenters <12 from symptoms onset.

However, by the governmental intervention the territory has already been prepared for a change in the mentality of AMI treatment during the previous 6 years of intense organizational efforts, and the first results have already been recorded in 2009, 1 year before the state intervention.

## LIMITATIONS OF THE STUDY

We underline that our data are representative for a region of Romania where a STEMI network was implemented since 2004 and covered all the hospitals, small or large, who received STEMI cases in this period, while Romania encounters globally significantly lower primary PCI rates.

## CONCLUSIONS

The national strategy for the reduction of STEMI related mortality via implementation of primary PCI, started in 2010, had a significant impact, especially in that region where the territory was previously prepared with appropriate organizational efforts, including education and logistic measures.

## ACKNOWLEDGEMENT

This paper was published under the frame of European Social Fund, Human Resources Development Operational Programme 2007-2013, project no. POSDRU/159/1.5/S/133377.

## REFERENCES

- Hasin Y, Danchin N, Filippatos GS, et al. Recommendations for the structure, organization, and operation of intensive cardiac care units. *Eur Heart J*. 2005;26:1676-1682.
- Van der Werf F, Bax J, Betriu A, et al, ESC Committee for Practice Guidelines (CPG). Management of acute myocardial infarction in patients presenting with persistent ST-segment elevation: the Task Force of Management of ST-Segment Elevation Acute Myocardial Infarction of the European Society of Cardiology. *Eur Heart J*. 2008;29:2909-2945.
- Gibson CM, Pride YB, Frederic PD, et al. Trends in reperfusion strategies, door-to needle and door-to balloon times, and in-hospital mortality among patients with ST elevation myocardial infarction enrolled in the National Registry of Myocardial Infarction from 1990 to 2006. *Am Heart J*. 2008;156:1035-1044.
- McDermott KA, Helfrich CD, Sales AE, Rumsfeld JS, Ho PM, Fihn SD. A review of interventions and system changes to improve time to reperfusion for ST-segment elevation myocardial infarction. *J Gen Intern Med*. 2008;23:1246-1256.
- Bauer T, Hoffman R, Junger C, et al. Efficacy of a 24-h primary percutaneous coronary intervention service on outcome in patients with ST elevation myocardial infarction in clinical practice. *Clin Res Cardiol*. 2009;98:171-178.
- Granger CB, Goldberg RJ, Dabbous O, et al. Predictors of hospital mortality in the global registry of acute coronary events. *Arch Intern Med*. 2003;163:2345-2353.
- Andersen HR, Nielsen TT, Rasmussen K, et al. A comparison of coronary angioplasty with fibrinolytic therapy in acute myocardial infarction. *N Engl J Med*. 2003;349:733-742.
- Keeley EC, Boura JA, Grines CL. Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction : a quantitative review of 23 randomized trials. *Lancet*. 2003;361:13-20.
- Widimsky P, Budesinsky T, Vorac D, et al, PRAGUE study group investigator. Long distance transport for primary angioplasty vs. immediate thrombolysis in acute myocardial infarction. Final results of the randomized national multicenter trial - PRAGUE -2. *Eur Heart J*. 2003;24:94-104.
- Gitt AK, Bueno H, Danchin N, et al. The role of cardiac registries in evidence-based medicine. *Eur Heart J*. 2010;31:525-529.
- Ting HH, Rihal CS, Gersh BJ, et al. Regional systems of care to optimize timeliness of reperfusion therapy for ST-elevation myocardial infarction: the Mayo Clinic STEMI protocol. *Circulation*. 2007;116:729-736.
- Ahmar W, Quarin T, Ajani A, Kennedy M, Grigg L. Improvement in door-to-balloon times in management of acute ST-segment elevation myocardial infarction STEMI through the initiation of 'Code AMI'. *Int Med J*. 2008;38:714-718.
- Holmes DR, Bell MR, Gersh BJ, et al. Systems of care to improve timeliness of reperfusion therapy for ST-segment elevation myocardial infarction off hours. *J Am Coll Cardiol Interv*. 2008;1:88-96.
- Jollis JG, Roettig ML, Aluko AO, et al. Implementation of a statewide system for coronary reperfusion for ST-segment elevation myocardial infarction. *JAMA*. 2007;298:2371-2380.
- Widimsky P, Wijns W, Fajadet J, et al. Reperfusion therapy for ST elevation acute myocardial infarction in Europe: description of the current situation in 30 countries. *Eur Heart J*. 2010;31:943-957.
- Mendoza C, Bhatt MR, Virani, Schob AH. Management of failed thrombolysis after acute myocardial infarction: An overview of current treatment options. *International Journal of Cardiology*. 2007;114;3:291-299.
- Tatu-Chitoiu G, Cinteza M, Dorobantu M, et al. In-hospital case fatality rates for acute myocardial infarction in Romania. *CMAJ*. 2009;180(12):1207-1213.
- Brieger D, Eagle KA, Goodman SG, et al. Acute coronary syndromes without chest pain, an underdiagnosed and undertreated high-risk group: insights from the Global Registry of Acute Coronary Events. *Chest*. 2004;126:461-469.
- Mandelzweig L, Battler A, Boyko V et al. The second Euro Heart Survey on acute coronary syndromes: characteristics, treatment, and outcome of patients with ACS in Europe and Mediterranean Basin in 2004. *Eur Heart J*. 2006;27:2285-2293.
- Cubeddu RJ, Cruz-Gonzalez I, Kiernan TJ, et al. ST-elevation myocardial infarction mortality in a major academic center "on-" versus "off-" hours. *J Invasive Cardiol*. 2009;21:518-523.