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Early Primary Percutaneous Coronary Intervention in Patients with ST-segment Elevation Acute Myocardial Infarction from the Cluj Area

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Abstract

Background: The seriousness of acute myocardial infarction (AMI) and the importance of its early detection and intervention are well known. Rapid reperfusion of the infarct area positively influences the immediate and long-term prognosis of patients with ST-segment elevation AMI. *Material and method*: Patients with acute myocardial infarction who underwent primary percutaneous transluminal coronary angioplasty (during the first 12 hours after the onset of chest pain) in the cardiac catheterization laboratory of the Cluj-Napoca "Nicolae Stancioiu" Heart Institute between November 2008 and February 2010 were followed prospectively in order to measure time-to-treatment intervals. *Results*: Our sample of 321 AMI patients included mostly males (73.8% of cases, 95% CI: 68.6-78.5; $p<0.001$) and patients from the urban area (67.6% of cases, 95% CI: 62.1-72.6; $p<0.001$) aged between 50 and 79 years. Total ischemia time (from onset of precordial pain to primary angioplasty) was 338.9 minutes on average (between 100 and 720 minutes); ambulance waiting time was 22.1 minutes (3-150 minutes); transport to first hospital took 49.9 minutes (5-276 minutes) while transport to a cardiology hospital averaged 247 minutes from the onset of pain (maximum 660 minutes). The door-to-balloon time was 91.9 minutes while early intervention was possible in 27.4% (95% CI: 22.7-32.7%) of AMI cases. *Conclusions*: Time-to-treatment intervals allowed early reperfusion in only one third of AMI patients due to lack of access to specialised cardiology hospitals in rural areas and inconsistencies regarding the attitude towards AMI cases across counties.

Keywords: ST-segment elevation acute myocardial infarction; Primary angioplasty; Time-to-treatment intervals; Total ischemia.

Introduction

The seriousness of acute myocardial infarction (AMI) and the importance of early detection and intervention are well known. Rapid reperfusion of the infarct area positively influences both immediate and long-term prognosis in ST-segment elevation AMI patients. Early reperfusion of the affected coronary vessel and successful myocardial reperfusion in acute myocardial infarction (AMI) improve immediate prognosis and reduce the risk of ischemia, re-infarction and stroke [1-3].

Death in the first phase of AMI occurs in 60% of cases mainly due to ventricular fibrillation [3, 4].

The American College of Cardiology and the American Heart Association recommend a maximum 12-hour interval between the onset of pain and reperfusion with stenting and a 90-minute interval from arrival at the first hospital to balloon inflation +/- stenting ("door-to-balloon" time) in order to reduce immediate mortality and the risk of re-infarction [5-10].

Primary percutaneous transluminal coronary angioplasty with stenting is currently the most advanced method of reperfusion available [11-14].

Knowledge of exact time-to-treatment intervals offers objective criteria for evaluating the effectiveness of therapeutic protocols and for establishing how various therapeutic methods should be associated in order to improve the prognosis of AMI patients [8, 9].

The Cluj County has integrated emergency services (112 call) that include Ambulance Service, mobile coronary unit, hospitals and the emergency service of the "Nicolae Stancioiu" Heart Institute. The aim of this paper was to establish time-to-treatment intervals in ST-segment elevation AMI patients from onset to coronary reperfusion with stenting in the cardiology unit of the "Nicolae Stancioiu" Heart Institute in order to evaluate the shortcomings of the current emergency service system and improve patient prognosis.

Material and Method

All ST-segment elevation AMI patients who underwent primary angioplasty in the "Nicolae Stancioiu" Heart Institute over a 16-month period between November 2008 and February 2010 were identified and monitored in order to establish exact time-to-treatment intervals from onset to coronary reperfusion with stenting. Patient selection criteria included confirmed acute myocardial infarction (pain and ECG changes: significant ST-segment elevation) treated with primary angioplasty, patient's or patient's relatives ability to provide information regarding the current AMI episode, and patient consent. Patients who failed to provide information regarding the events that took place between the onset of pain and hospital admission, patients who refused to participate in the study as well as those with a previous infarction, were not included.

A chart for each selected case was used to record patient's age, gender, urban/rural domicile, localization of the infarct, date and time of pain onset, time of emergency call, time of ambulance arrival, time of arrival at the first hospital, time of arrival at the emergency room of the Heart Institute, time of arrival at the catheterization laboratory, time of angioplasty balloon inflation. Time intervals in minutes were calculated from the onset of precordial pain to treatment.

Statistical analysis established patient characteristics according to gender, age, urban/rural origin and time intervals between the onset of infarction and admission to the cardiology hospital for primary angioplasty ± stenting.

Results

A number of 321 patients with ST-segment elevation AMI who met the selection criteria were included in the study between November 2008 and February 2010. Out of the patients included in the study, 64.8% were from the Cluj County while the others were from North-Western, Central and Western Romania's counties. Patients were mostly from the urban area - 67.6% of cases (95% CI: 62.1-72.6; $p<0.001$) and male - 73.8% of cases (95% CI: 68.6-78.5; $p<0.001$) (Table 1). The local structure of the population at the time (48.9% male, 56.3% urban) did not change the significance of the differences found [15].

The average patient age (measured in full years) was 59.9 years (between 24 and 88) and most patients were between the 5th and 7th age decade (Figure 1).

Table 1. Distribution of acute myocardial infarction cases according to gender, origin and area

Characteristic	No. of cases	Percentage (%)	95% CI	p
Gender: - male	237	73.8	68.6-78.5	p<0.001
- female	84	26.2	21.5-31.4	
Origin: - urban	217	67.6	62.1-72.6	p<0.001
- rural	104	32.4	27.4-37.9	
Area: - Cluj	208	64.8	59.3-70	p<0.001
- other counties	113	35.2	30-40.7	
Total no. of cases	321	100	-	-

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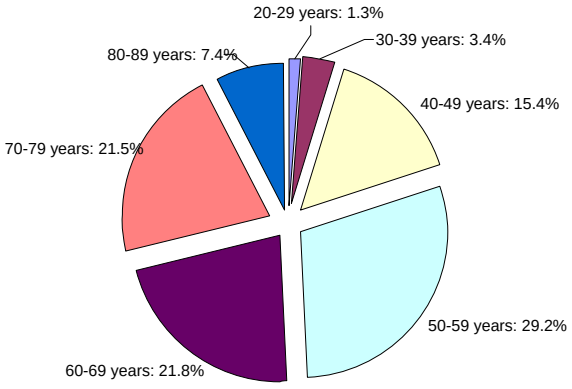

Figure 1. Age group distribution of patients with acute myocardial infarction included in the study

Reperfusion by primary angioplasty ± stenting within the first 3 hours after onset of precordial pain was performed in 27.4% of patients while most patients (40.8%) underwent primary angioplasty 6 hours after pain onset (between 6 and 12 hours) (Table 2).

Table 2. Case distribution according to time intervals in hours between the onset of coronary ischemia and treatment

Time interval in hours	No. of cases	Percentage (%)	95% CI	p
0-3	88	27.4	22.7-32.7	p<0.05
3-6	102	31.8	26.8-37.2	p<0.05
6-12	131	40.8	35.4-46.4	p<0.05
Total	321	100	-	-

Two hundred (62.3%) patients made an emergency call to 112 after an average of 64.5 minutes (with variations from immediate call to 450 minutes; I1) after the onset of chest pain. The waiting time between emergency call and ambulance arrival was 22.1 minutes (minimum 3 and maximum 150 minutes; I2) (Table 3) in all patients except for one, who left for the hospital before the ambulance arrived.

The ambulance trip to the first hospital (I3) lasted 49.9 minutes on average, with variations between 5 and 276 minutes (Table 3).

Patient transfer from the first hospital (I4) to the cardiology hospital took an average of 111.4 minutes (maximum 451 minutes). An I4=0 interval was registered in 64 patients who was admitted directly in the Heart Institute Cluj-Napoca. The following time intervals were recorded within the Heart Institute:

- The time interval between arrival at the emergency room and arrival at the catheterization laboratory (I5) was 50.9 minutes (minimum 5 and maximum 324 minutes), during which time patients had to be clinically stabilized,

- The time interval between arrival at the catheterization laboratory and angioplasty balloon inflation (reperfusion of the affected vessel) (I6) was 41 minutes (minimum 10 and maximum 115 minutes) (Table 3, Figure 2).

The time elapsed from patient arrival at the emergency room of the Heart Institute to reperfusion of the affected vessel was 91.9 minutes on average (minimum 15 and maximum 374 minutes) (Table 3, Figure 2).

Patients received medical care from onset of pain to arrival at the cardiology hospital (I8) for an average of 247 minutes, with variations from immediate care to 660 minutes (Table 3, Figure 2).

The total ischemia time (IT), i.e. the time from onset of pain to reperfusion of the coronary vessel lasted for an average of 338.9 minutes, with variations between 100 and 720 minutes (Table 3, Figure 2).

Table 3. Time intervals in minutes for patients with acute myocardial infarction

Variable*	No. of cases	Average	Standard deviation	Minimum	Maximum
I1	200	64.5	83.3	0	450
I2	199	22.1	18.4	3	150
I3	199	49.9	42.3	5	276
I4	321	111.4	107.9	0	451
I5	321	50.9	48.7	5	324
I6	321	41	17.4	10	115
I7	321	91.9	51	15	374
I8	321	247	132.9	0	660
IT	321	338.9	140.3	100	720

*: I1: pain-emergency call interval; I2: emergency call-ambulance arrival interval; I3: ambulance arrival – arrival at first hospital interval; I4: first hospital – arrival at the Heart Institute interval; I5: arrival at the Heart Institute – arrival at the catheterization lab interval; I6: arrival at the catheterization lab – angioplasty balloon inflation interval; I7: arrival at the Heart Institute – balloon inflation interval (I5+I6); I8: pain - arrival at the Heart Institute interval (I1+I2+I3+I4); IT: pain – balloon inflation interval (total ischemia time = I7+I8)

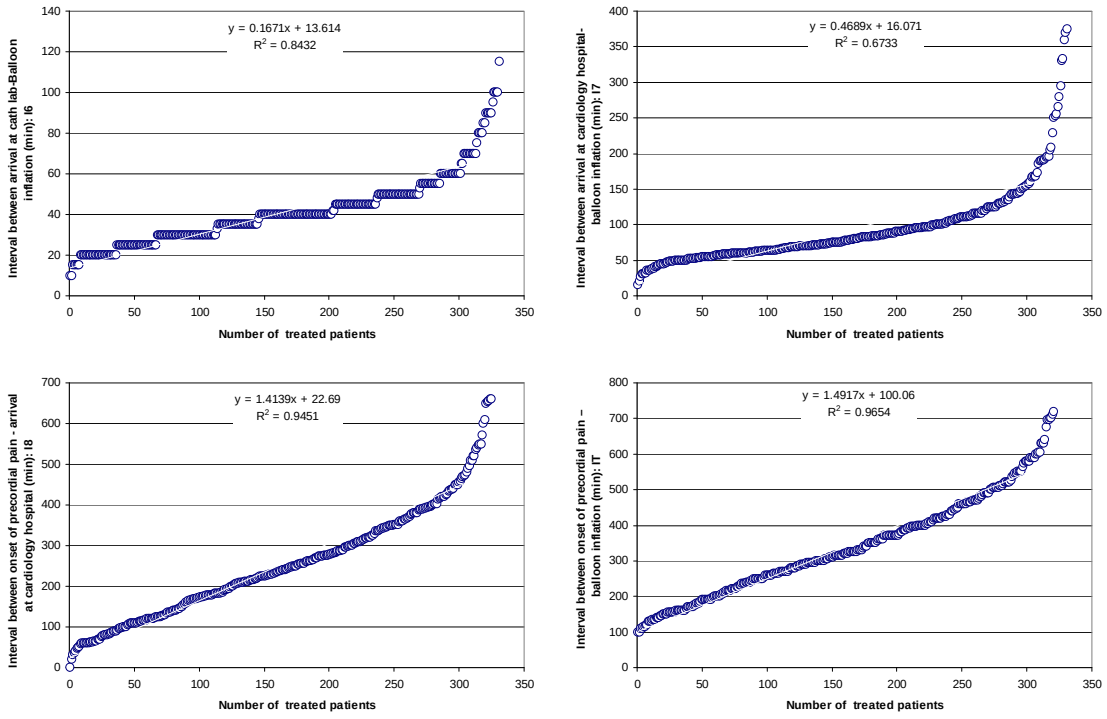

Figure 2. Duration of percutaneous coronary angioplasty (I6), patient transfer within the cardiology hospital (I7), time from infarction onset to intervention (I8) and total ischemia time (IT).
Note: I6: arrival at catheterization lab – balloon inflation interval; I7: arrival at the Heart Institute – balloon inflation interval (I5+I6); I8: pain – arrival at the Heart Institute interval (I1+I2+I3+I4); IT: pain – balloon inflation interval (total ischemia time: I7+I8).

No significant differences were found in time-to-treatment intervals as far as patient gender was concerned. Longer time intervals were registered in patients from the rural area, especially from ambulance arrival to arrival at the first hospital, which consequently led to longer time to coronary reperfusion (Table 4). Intervals I5 and I6, which took place after patient arrival at the Heart Institute, did not show statistically significant differences in patients from the urban and rural area.

Table 4. Comparative analysis of time-to-treatment in patients with acute myocardial infarction according to urban/rural origin

Variable*	Cases in the rural area				Cases in the urban area				Statistical test	
	No	m	StDev	Min./ Max.	No	m	StDev	Min./ Max.	p	Significance
I1	57	78.4	87.41	3 / 420	143	58.9	81.31	0 / 450	0.032365	KW S
I2	57	32.84	16.88	10 / 75	142	17.78	17.19	3 / 150	0.000001	KW S
I3	57	68.45	57.67	12 / 276	142	42.42	31.64	5 / 271	0.000338	KW S
I4	104	125.38	109.53	0 / 451	217	104.7	106.75	0 / 418	0.082405	KW NS
I5	104	51.59	55.78	5 / 310	217	50.52	45.09	5 / 324	0.212991	KW NS
I6	104	42.16	16.54	13 / 100	217	40.44	17.81	10 / 115	0.230036	KW NS
I7	104	93.76	58.09	20 / 360	217	90.96	47.42	15 / 374	0.697450	KW NS
I8	104	297.45	126.87	50 / 653	217	222.88	129.11	0 / 660	0.000002	KW S
IT	104	391.21	134.3	110 / 700	217	313.84	136.38	100 / 720	0.000003	KW S

No = number of cases; m = average; StDev = standard deviation;
KW- Kruskal Wallis test; T –T test (Student); SD –standard deviation; S = significant test ($p<0.05$);
NS = non-significant test ($p \geq 0.05$); I1: pain – emergency call interval; I2: emergency call – ambulance arrival interval;
I3: ambulance arrival – arrival at first hospital interval; I4: first hospital – arrival at the Heart Institute interval;
I5: arrival at the Heart Institute – arrival at the catheterization lab interval,
I6: arrival at the catheterization lab – balloon inflation interval; I7: arrival at the Heart Institute - balloon inflation interval (I5+I6);
I8: pain - arrival at the Heart Institute interval (I1+I2+I3+I4); IT: pain – balloon inflation interval (total ischemia time; I7+I8).

Compared with patients from other counties, the interval between ambulance arrival and arrival at the first hospital (I3) as well as the interval from arrival at the cardiology hospital to reperfusion of the affected vessel (I7) were significantly longer in Cluj county patients while transfer time from the initial hospital to the cardiology hospital (I4) and the time from pain onset to arrival at the cardiology hospital (I8) were significantly shorter (Table 5).

Table 5. Statistical comparison of average intervals in patients with acute myocardial infarction according to county

Variable*	Cluj				Other counties				Statistical test	
	No	m	StDev	Min. / max.	No	m	StDev	Min. / max.	p	Significance
I1	147	69.05	87.74	0/450	53	51.85	68.87	0/420	0.103450	KW NS
I2	146	22.66	19.37	4/150	53	20.53	15.40	3/70	0.326673	KW NS
I3	146	51.77	38.98	9/276	53	44.66	50.53	5/271	0.004315	KW S
I4	208	70.95	87.93	0/418	113	185.87	101.77	0/451	0.000001	KW S
I5	208	54.01	45.10	5/324	113	45.10	45.10	5/280	0.062517	T NS
I6	208	41.51	17.96	10/115	113	40.07	16.38	10/100	0.481723	T NS
I7	208	95.51	52.76	20/374	113	85.17	47.23	15/360	0.029126	KW S
I8	208	215.93	133.36	0/685	113	304.30	111.67	50/660	0.000001	KW S
IT	208	311.44	142.95	100/710	113	389.47	120.29	140/720	0.000001	KW S

No = number of cases; m = average; StDev = standard deviation;
KW- Kruskal Wallis test; T –T test (Student); SD –standard deviation; S = significant test ($p<0.05$); NS = non-significant test ($p \geq 0.05$);
I1: pain – emergency call interval; I2: emergency call – ambulance arrival interval; I3: ambulance arrival – arrival at first hospital interval;
I4: first hospital – arrival at the Heart Institute interval; I5: arrival at the Heart Institute – arrival at the catheterization lab interval,
I6: arrival at the catheterization lab – balloon inflation interval; I7: arrival at the Heart Institute - balloon inflation interval (I5+I6);
I8: pain - arrival at the Heart Institute interval (I1+I2+I3+I4); IT: pain – balloon inflation interval (total ischemia time; I7+I8).

Discussion

The epidemiological characteristics and evolution of AMI continue to indicate its prevalence regardless of gender (in favour of the male gender), age and origin [16, 17].

The study of the epidemiology of AMI may influence therapeutic attitude based on objective criteria (evidence-based clinical decision). The community health implications include adequate prevention measures, better healthcare, health insurance and professional risk policies as well as other health programs [6].

Rapid reperfusion of the affected vessel in acute myocardial infarction cases is a key factor for better patient prognosis. Approximately one third of the patients included in our study underwent intervention within the first 3 hours after AMI onset. The factors responsible for reducing time-to-treatment must be evaluated in order to ensure early reperfusion.

The average door-to-balloon time, i.e. the time between arrival of AMI patient at the emergency room and angioplasty balloon inflation (I5+I6) was 91.9 minutes. This value is higher than that obtained by the Calgary centre, which was 62 minutes (between 45 and 84 minutes), but lower than the 93 minutes (7-200) obtained by studies carried out in the United States of America [5, 18].

However, the total ischemia time (IT) in ST-segment elevation AMI patients who underwent primary angioplasty at the Cluj centre was 338.9 minutes on average (between 100 and 720 minutes), longer than the 188 minutes (between 41 and 447) recorded in the United States (18). The total ischemia time was significantly longer due to the I1 interval (between the onset of precordial pain and emergency call), which was significantly higher in rural area patients, and the I3 and I4 intervals (arrival at the first hospital and then at the Heart Institute). These delays show the lack of healthcare education and patient transport/transfer difficulties.

The significant differences between the urban and rural area were caused by long distances and difficult access from the rural area to the cardiology hospital. This particularity reflects the complexity of healthcare and the underestimation of AMI occurrence by failure to diagnose real cases with poor access to cardiology services.

Faster arrival of patients from counties other than Cluj at the first hospital could be improved by better traffic or quick decisions in cases of suspected myocardial infarction. The significant differences across counties suggest an inconsistent attitude concerning the medical recommendations involved in diagnosing suspected myocardial infarction.

Conclusions

1. Male patients with ST-segment elevation AMI from the urban environment benefitted most from coronary reperfusion by primary angioplasty in a cardiology hospital.
2. After arrival at the cardiology centre, the promptness of specialized care does no longer depend on patient origin, age or gender as early primary angioplasty (within the first 3 hours after onset of pain) was performed in only one third of ST-segment elevation AMI patients who presented at the Cluj-Napoca Heart Institute.
3. AMI patients from the rural area waste valuable time due to transport difficulties, which causes reduced access to a highly specialized cardiology service.
4. Given the inconsistent attitude regarding AMI cases across counties, the Heart Institute should facilitate access to specialized care by coordinating the methodological and operational aspects involved.

Ethical Issues

All medical acts were performed after informed consent of patients.

Conflict of Interest

The author(s) declare that they have no conflict of interest.

Authors' Contributions (not compulsory)

Eva Deak was responsible for the selection of patients, construction of the data base and the manuscript preparation. Ştefan Ţigan performed de statistical analysis. Irina Brumboiu was involved in data interpretation and manuscript preparation. Ioan Bocşan coordinated the study and reviewed the data. All authors revised the manuscript and approved the final version to be published.

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