**American Journal of Internal Medicine**
2016; 4(4): 75-78
http://www.sciencepublishinggroup.com/j/ajim
doi: 10.11648/j.ajim.20160404.13
ISSN: 2330-4316 (Print); ISSN: 2330-4324 (Online)

# Mortality in a Primary and Secondary Transported of STEMI Patients, a Prospective Study

**Al Mawiri A.[1, *], Stasek J.[1], Vojáček J.[1], Bis J.[1], Albahri Z.[2]**

[1]Department of Cardiovascular Medicine, Faculty Hospital, Charles University in Hradec Králové, Hradec Králové, Czech Republic
[2]Department of Pediatrics, Faculty Hospital, Charles University in Hradec Králové, Hradec Králové, Czech Republic

## Email address:

A.Mawiri@seznam.cz (Al Mawiri A.)
[*]Corresponding author

## To cite this article:

Al Mawiri A., Stasek J., Vojáček J., Bis J., Albahri Z. Mortality in a Primary and Secondary Transported of STEMI Patients, a Prospective Study. *American Journal of Internal Medicine*. Vol. 4, No. 4, 2016, pp. 75-78. doi: 10.11648/j.ajim.20160404.13

**Received**: June 30, 2016; **Accepted**: July 19, 2016; **Published**: July 29, 2016

**Abstract:** In ST-elevation myocardial infarction (STEMI), the pre-hospital phase is the most critical and appropriate treatment in a timely manner which is instrumental for mortality reduction. STEMI systems of care based on networks of medical institutions connected by an efficient emergency medical service (EMS) are pivotal. The first steps are devoted to minimizing patient's delay in seeking care, quickly dispatching emergency personnel with equipped ambulance to be able to make the diagnosis on scene, deliver initial drug and therapy and also transport the patient to the most appropriate (not necessarily the closest) cardiac facility or hospital. Primary percutaneous coronary intervention (PCI) is a treatment of choice, but thrombolysis followed by coronary angiography and possibly PCI are valid alternatives. Strong cooperations between cardiologists and emergency medicine doctors are mandatory for optimal pre-hospital STEMI care. In this study, we prospectively recorded door to balloon time (DBT) for consecutive patients with STEMI, treated by PCI. For six hundred and seventy seven patients with mean 64 ± 16 years, 475 (70%) males and 202 (30%) females were enrolled for the final analysis. From this number, 354 (52.3%) patients had primary transport by emergency services (PT) and 323 (47.7%) secondary transport (ST). Median of DBT was 34±15.9 mins for PT patients (n=354) and 100±28.8 mins for patients with ST (n=323) ($p<0.00005$). One month mortality rate was 4% vs 9.5% ($p=0.002$) in the PT vs ST group, respectively. One-year mortality rate in the PT and ST groups were 7.3% vs 20.5% ($p<0.005$), respectively. We found out that patients who were sent directly to a PCI center had significantly shorter time for reperfusion and lower mortality.

**Keywords:** STEMI, Prehospital Treatment, Door to Balloon Time and Mortality

## 1. Introduction

The importance of time aspects in the treatment of patients with ST segment elevation myocardial infarction (STEMI) is stressed both in the American College of Cardiology and the European Society of Cardiology guidelines [1, 2]. A primary transport (PT) of a patient with STEMI directly into the Cardiac Centers with feasibility of an immediate primary percutaneous coronary intervention (PCI) and not to the nearest hospital is recommended [1, 2]. Organization of care for patients with STEMI, especially with compression times since the onset of symptoms to perform d-PCI is unthinkable without closed cooperation between Cardiac Center and the medical emergency services. On the side of the emergency services, the early diagnosis and correct decision are crucial.

Since 2006, it is an obvious opportunity to make diagnosis of STEMI by emergency medical service (EMS) crew in the region of Hradec Kralove either by the direct diagnosis (medical Crew) or via telemedicine where ECG is sent to a consulting Cardiologist directly to the Cath- Lab. This option is not only mandatory use of all non-medical crew but also for doctors in the case of diagnostic uncertainty. The diagnostics as well as determining direction of the initial treatment are handled similarly. Direction and determining treatment on the site of the event in case of medical crew pharmacists.

In real situations, many delays in both pre-hospital and hospital phases of initial care for patients with STEMI may

take place. The pre-hospital phase comprises "symptom onset – phone" time, which is affected mainly by public education, and "phone – admission to a Cardiac Center" time, which is mainly influenced by the organization network and the quality of given pre-hospital emergency medical care system. Hospital phase from admission to opening of the infarction-related artery, reflected in the door-to-balloon time (DBT), is mainly influenced by activities and organization of a Cardiac Center. Because of the proved link between the DBT and mortality of STEMI patients, an effort to minimize all in-hospital delays is of a great importance [3-8].

The aims of our study were to assess to what extent the primary admission of a STEMI patient to non-PCI centers or PCI Center Coronary Care Unit (CCU) (secondary transport – ST) prior to PCI, instead of the direct transport to the catheterization laboratory (PT) which greatly influences the DBT and affects mortality of patients with STEMI.

## 2. Patients and Methods

We have prospectively analyzed DBT and mortality of patients with STEMI admitted from to the Cardiac Center of the University Hospital in Hradec Kralove, Czech Republic, both primarily transported from the point of first medical contact (FMC) and secondarily from non-PCI centers. In addition to DBT, we have also recorded the mode of patient's initial transfer (i.e. direct transport to the catheterization laboratory, to non-PCI center first, or to PCI center CCU with a subsequent transfer to the catheterization laboratory) and the reasons for various delays in individual patients.

Inclusion criteria were: patients with STEMI which had reperfusion (first dilatation by balloon or primo-stenting) within 12 hours after first chest pain. Patients who did not fulfill these criteria were excluded.

The total of 869 patients (age 20-96 years, mean 64 ± 12.3 years, 618 i.e. 71.1% were men and 251, i.e. 28.9% women) with the working diagnosis of STEMI were admitted to the Cardiac Center**.**

## 3. Results

Basic clinical data of patients in the study as shown in table (1) and localization of the STEMI in the original group of 869 patients referred to the tertiary center also shown in table (2).

From this basic cohort a total of 192 patients were not enrolled for the final analysis, the reasons were shown in Table (3). 677 patients, age 37-96 years, mean 64 ± 16 years, 475 (70%) of them males and 202 (30%) females, were enrolled for the final analysis. From this number, 354 (52.3%) patients were primarily transported directly by medical emergency services to the catheterization laboratory (PT) and 323 (47.7%) patients were transported to regional hospitals or to the Coronary Care Unit of the Cardiac Center and only then to the catheterization laboratory (ST).

The mortality data (Figure 1 and 2) were obtained from the Institute of Health Information and Statistics of the Ministry of the Health, Czech Republic and from the Czech National Register of Cardiovascular Interventions which updates regularly, information about the death of any subject in the Registry.

Normality of data was verified by the Kolmogorov-Smirnov test. Due to the non-normal distribution of the DBT, we used the median as a position descriptor and the interquartile range as a variability descriptor.

***Table 1.*** *Basic clinical data of patients in the study, DM=diabetes mellitus, AMI=Acute Myocardial Infarction, CABG=Coronary Artery Bypass Graft, PCI=Percutaneous Coronary Intervention, PT=primary transport, ST=secondary transport.*

| **Risk factors** | **PT n = 354** | | **ST n = 323** | |
|---|---|---|---|---|
| | **n** | **%** | **n** | **%** |
| DM | 57 | 16.1 | 62 | 19.2 |
| Hypertension | 166 | 46.9 | 156 | 48.3 |
| Dyslipidemia | 68 | 19.2 | 79 | 24.5 |
| Previous AMI | 28 | 7.9 | 35 | 18.8 |
| Previous CABG | 9 | 2.5 | 13 | 4.0 |
| Previous PCI | 27 | 7.6 | 30 | 9.3 |
| Previous Ischemic brain stroke | 9 | 2.5 | 16 | 4.9 |
| Chronic Lower Limb Ischemia | 9 | 2.5 | 16 | 4.9 |
| Active smoker | 132 | 37.3 | 90 | 27.9 |
| Stop smoker | 49 | 13.8 | 95 | 29.4 |

***Table 2.*** *Localization of the STEMI in the original group of 869 patients referred to the tertiary center. LBBB=left bundle branch block.*

| **Localization STEMI** | **N (%)** |
|---|---|
| diaphragmatic wall | 434 (*49.9*) |
| anterior wall | 362 (*41.7*) |
| lateral wall | 41 (*4.7*) |
| LBBB | 32 (*3.7*) |
| Total | 869 (*100*) |

***Table 3.*** *Reasons for not including patients to the long-term follow-up from the original group of 869 patients referred to the tertiary center with the diagnosis of STEMI. PCI=Percutaneous Coronary Intervention.*

| **Clinical condition** | **n (%)** |
|---|---|
| acute bypass surgery | 18 (2.1) |
| diffuse coronary artery disease, PCI not performed | 66 (7.6) |
| coronary angiography without significant stenosis | 25 (2.9) |
| coronary artery spontaneous dissection | 3 (0.3) |
| late reperfusion | 54 (6.2)>12 hours |
| death during PCI | 5 (0.6) |
| unsuccessful PCI | 14 (1.6) |
| Pericarditis | 4 (0.5) *1 |
| hypertrophic cardiomyopathy | 2 (0.2) *2 |
| dissection of the thoracic aorta | 1 (0.1) |
| TOTAL | 192 (22.1) |

*1: no STEMI in final diagnosis, *2: no STEMI in final diagnosis

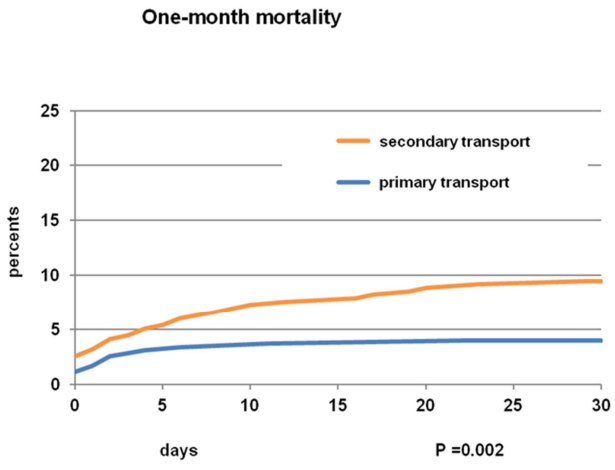


***Figure 1.*** *One-month mortality.*

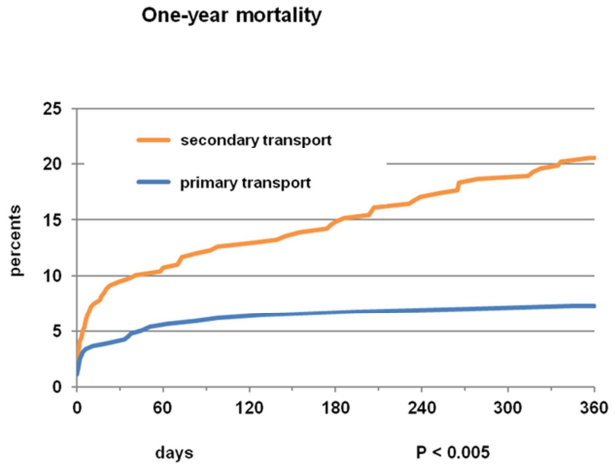


***Figure 2.*** *One-year mortality.*

## 4. Discussion

Reperfusion therapy by primary coronary angioplasty is accepted standard of treatment for patients with STEMI lasting less than 12 hours and under some circumstances also for patients with symptoms lasting more than 12 hours. Symptom onset-to-balloon time, but not DBT, is a main predictor of mortality, particularly in non-low-risk patients and in the absence of pre-procedural anterograde flow. Furthermore, a symptom onset-to-balloon time more than 4 hours was identified as independent predictor of one-year mortality [7].

Our study Compares DBT and short-term as well as one-year mortality of direct transport of patients from the field to catheterization laboratory with other routes to primary PCI and shows that direct pattern not only significantly shortens DBT but also results in significant decrease of one-month and one-year mortality. We confirmed in our study low mortality in patients with STEMI and with the short DBT.

Analysis the results showed that the transfer of patients with STEMI to non-PCI centers or the PCI-hospital CCU – as compared to the primary transport to the catheterization laboratory – results in a very significant time prolongation prior to opening the infarct-related artery, in median by more than 1 hour. The delay of opening the infarct-related artery significantly affected 1-month as well as 1-year mortality. One of the possible delays in hospital phase results from coronary care (or intensive care) unit stay prior to the PCI. The reason for admission of patients with STEMI to the PCI-hospital CCU was typically delay of the catheterization laboratory team activation by the pre-hospital emergency medical service or the inability to quickly release one of the catheterization laboratories at the time of STEMI patient arrival.

The reason for transporting patients with STEMI to non-PCI hospitals is most frequently, the lack of experience to correctly evaluate ECG by attending physicians or paramedics. Although the patients from the mountains and remote parts of the regions were transported by helicopter, the delay time in 32% of patients with STEMI in our group was caused by members of the emergency services, where despite all the instructions from the Cardiac Center some patients with STEMI were transported to the nearest medical facility or through the Emergency Department of University Hospital in Hradec Kralove which contributed the inability of doctors to correctly evaluate ECG and then they prefer instead of sending ECG to Cardiac Center transported through the ambulances where sometimes they did not make ECG especially in resuscitated patients that were transported to the nearest hospital.

Another problem was in some cases were they only dispatch rescuers without the physician and then the patients with STEMI were taken to the nearest facility. For example, four patients with chest pain were kept in place by a doctor and considered the chest pain from the back.

This study shows that each EMS system should maintain a standardized algorithm for evaluating and treating patients with symptoms suggestive of myocardial ischemia that should include acquisition of a 12-lead ECG and appropriate communication of the ECG findings to the receiving hospital.

Each EMS system should maintain a standardized reperfusion STEMI care pathway that designates primary PCI as the preferred reperfusion strategy if initiated within 90 minutes of first medical contact or fibrinolytic therapy in eligible patients when primary PCI within 90 minutes is not possible. Prearranged EMS destination protocols for STEMI patients should include:

a. Bypassing non-PCI hospitals/STEMI Referring Centers and going directly to primary PCI hospitals/STEMI-Receiving Centers for patients with anticipated short transport interval (e.g. <30 minutes in urban/suburban settings, so as to achieve primary PCI within 90 minutes).

b. Emergency transfer by EMS or other agencies to a STEMI-Receiving Center of patients with STEMI who transport themselves to a STEMI Referring Center.

c. Air transport if possible (or default to ground transport ) to STEMI-Receiving Center or stabilization in STEMI Referring Center for patients with anticipated long transport time and/or either fibrinolytic ineligible and/or in cardiogenic shock.

d. Administration of fibrinolytic therapy prehospital or in a

STEMI Referring Center for fibrinolytic eligible patients with anticipated time to primary PCI exceeding 90 minutes

e. Emergency transfer to a STEMI-Receiving Center of patients who develop STEMI while in hospital at STEMI Referring Center (non-PCI hospital).

Direct transport of patients with STEMI and its influence on DBT was analyzed in several studies.

Self-transportation without EMS and inter-hospital transportation are significant factors in causing prolongation of the transport time. Fujii T with his coworkers [9] reported that approximately 35% of STEMI patients did not use EMS and 21% of patients were transported to non-PCI facilities even though they called EMS. Awareness in the community as well as among medical professionals to reduce total ischemic time of STEMI is necessary; this involves educating the general public and EMS crews [9].

Dorsch MF et al in another study found that directly admitted patients had significantly reduced DBT (58 vs 105 minutes, $p< 0.001$) and call-to-balloon time (105 vs 143 minutes, $p <0.001$). The 90-minute target for DBT was achieved in 94% of direct admissions compared to only 29% of patients referred from the emergency room [10]. Their data correspond to our study with DBT 34±15.9 minutes for patients directly transferred to catheterization laboratory as compared to 100±28.8 minutes for secondary transport.

## 5. Conclusion

We have found out that patients who were sent directly to a PCI center had significantly shorter time to reperfusion and lower mortality. Strong cooperation between cardiologists and emergency medicine doctors is mandatory for optimal pre-hospital STEMI care. The basic objective is the compression of time since the inception symptoms in infarct artery patency through direct PCI. The current task of rescue services in the Czech Republic are to provide the same level of care for patients which strikes the doctor and especially for those to which the doctor for different reasons in the prehospital get care. It requires organizational measures and clear laid down rules to securely, effectively and legally achieve the objectives. Not withstanding the use of thrombolytic therapy for STEMI is a condition in the pre-hospital care possible. The benefits and reasons of introducing this method in pre-hospital phase in the Czech Republic are undoubtedly at least questionable.

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