Impact of emergency services and ambulance type on pain-to-balloon time in the acute myocardial infarction: an observational study

Akut miyokart enfarktüsünde acil servis ve ambulans tipinin ağrı-balon süresine etkisi: Gözlemsel bir çalışma

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ABSTRACT

Objective: The objective of this study was to evaluate the role of first contact emergency departments and ambulances on transport duration, pain-to-balloon time, door-to-balloon time and first contact-to-balloon time in acute myocardial infarction (AMI) patients.
Methods: The study was a prospective and observational investigation. A total of 374 AMI patients initially admitted to primary coronary intervention (PCI) incapable centers were included in this study. Patients were classified according to initial presentation site (daily clinic, public hospital or private hospital) and transport manner (public or private ambulance). All groups were compared by the Kruskal-Wallis and Mann-Whitney U tests statistically according to their characteristics, transport duration and pain-to-balloon time.
Results: A majority of the patients were initially admitted to public (40.1%) or private hospitals (47.1%). The average door-to-balloon time was 45.0±18.5 min and the mean pain-to-balloon time was 310.6±160.8 min. Nearly half of the patients initially admitted to daily clinics were first transported to PCI-incapable centers, leading to delayed admission to PCI-capable centers and increased pain-to-balloon and first contact-to-balloon times (361.7±194.5 min, p=0.01 and 279.7±158.2 min, p<0.001). Patients admitted to private hospitals experienced shorter average pain-to-balloon and first contact-to-balloon times (277.5±148.6 min, p=0.01 and 157.4±83.1 min, p<0.001). Patients transported by private ambulances also experienced shorter waiting times and shorter pain-to-balloon times (107.4±70.4 and 270.1±150.4 min, p<0.001).
Conclusion: Physicians and healthcare professionals in first contact emergency departments and ambulance type appear to be factors in the increased pain-to-balloon time. AMI patients are often initially admitted to PCI-incapable centers, leading to delayed admission to PCI-capable centers and increased pain-to-balloon time. *(Anadolu Kardiyol Derg 2012; 12: 23-9)*
Key words: Emergency services, ambulance, pain-to-balloon time

ÖZET

Amaç: Bu çalışma ileriye dönük gözlemsel bir araştırma olup; akut miyokart enfarktüslü (AME) hastalarında, ilk başvurulan acil servis ile ambulans tipinin hasta nakil süresi, ağrı-balon zamanı, kapı-balon süresi ve ilk kontak-balon süresi üzerindeki etkilerini araştırmayı amaçladık.
Yöntemler: İlk olarak primer koroner girişim (PKG) imkânı olmayan hastanelere başvuran toplam 374 AMI hastası çalışmaya dâhil edildi. Hastalar ilk başvurdukları merkezlere göre; günlük klinik-tıp merkezi, devlet hastanesi ve özel hastane grubu olarak sınıflandırıldı. Hastalar aynı zamanda nakil sırasında kullanılan ambulans tipine göre de 112 ambulansı veya özel ambulans olarak iki grupta sınıflandırıldı. Tüm gruplar Kruskal-Wallis ve Mann-Whitney U testleri ile istatistiksel olarak demografik özellikler, nakil süresi ve ağrı-balon zamanına göre karşılaştırıldı.
Bulgular: Hastaların çoğunluğu ilk olarak devlet hastanesi veya özel hastaneye başvurmuştu (40.1% ve 47.1%). Ortalama kapı-balon süresi 45.0±18.5 dakika, ortalama ağrı-balon süresi 310.6±160.8 dakika olarak saptandı. Günlük klinik-tıp merkezine başvuran hastaların yarıya yakını PKG imkanı olmayan merkezlere sevk edilmişti ve bu durum ağrı-balon süresi ve ilk kontak-balon süresinin bu grupta daha uzun olmasına sebep olmuştu (361.7±194.5 dk, p=0.01 ve 279.7±158.2 dk, p<0.001). Özel hastanelere başvuran grupta göreceli olarak daha kısa ağrı-balon ve ilk kontak-balon süresi mevcuttu (277.5±148.6 dk, p=0.01 ve 157.4±83.1 dk, p<0.001). Özel ambulans ile nakil yapılan hasta grubunda da nakil süresi ve ağrı-balon zamanı daha kısaydı (107.4±70.4 dk ve 270.1±150.4 dk, p<0.001).
Sonuç: Acil servis çalışanları ve doktorları, hasta naklinde kullanılan ambulans tipi ağrı-balon süresinde uzamaya sebep olabilmektedir. AMI hastalarının öncelikle PKG imkânı olmayan merkezlere sevki, PKG imkânı olan merkeze ulaşımı ve ağrı-balon zamanını uzatmaktadır.
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Anahtar kelimeler: Acil servis, ambulans, ağrı-balon süresi

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Introduction

Acute myocardial infarction (AMI) is a leading cause of mortality and morbidity in the world. Nearly one-third of AMI-related deaths occur within the first few hours of the onset of symptoms and usually before patients reach the hospital (1). Despite the fact that early reperfusion is critical for the treatment of AMI, and every minute of delay can affect patient mortality and morbidity (2), various studies have reported that many AMI patients experience prolonged prehospital transport delays (3-11).

However, these studies only focused on demographic and regional characteristics of the patients (8-11), while the role of the emergency department as a point of first medical contact, and ambulance type (e.g. private or public) remains understudied, and has not been systematically studied before in Turkey.

Therefore, in this study, we aimed to investigate the role of first admission emergency departments and ambulance type on the time period between the onset of symptoms and reperfusion (pain-to-balloon time) in acute myocardial infarction (AMI) patients.

Methods

Study design

It was a prospective and observational study performed in the European side of İstanbul.

Patient population

A total of 374 consecutive patients diagnosed with ST elevation AMI (between September 2009 and September 2010) who met the inclusion criteria were included in this study. Exclusion criteria were as follows: patients diagnosed with non-ST elevation MI or unstable angina; patients who did not recall the exact time of initial symptoms; unconscious patients; patients directly admitted to primary percutaneous coronary intervention centers; and patients who did not want to participate in the study. Data was collected from 3 different private cardiac centers capable of primary coronary intervention (PCI) in İstanbul, Turkey (İstanbul Medicine Hospital, Bağcılar; Medicana Hospital, Bahçelievler and Medical Park Hospital, Fatih). All 3 PCI centers are close in proximity (~10 km distance from each other), and together offer healthcare for nearly 4 million people from 3 neighboring district in İstanbul (Fatih, Bahçelievler and Bağcılar). In addition, all three are well-known referral centers for AMI patients and they performed more than 100 primary PCIs and also 400-700 total PCIs in the 2010. Teams for primary PCI are ready for 24 hours and 7 days in a week in these three centers. Although all 3 centers are private hospitals, the cost of PCI treatment is similar to that incurred in public hospitals and AMI patients can be treated without any extra-charge. In the European side of Istanbul, there are approximately 30 primary PCI capable centers (three public hospitals, three university hospitals and rest is private centers) which enable easy and fast transport of AMI patients for primary PCI.

This study was approved by the Ethics Committee of the hospitals. All the patients were informed of the study design, and signed informed patient consent forms were obtained from all patients before interviews were conducted.

Study protocol

All patients were interviewed by a physician within 24 hours of presentation, after successful reperfusion. Onset of symptoms, first application, ambulance transport, sociodemographic and clinical characteristics were documented. When available, data was also collected from the relatives of patients, ambulance physicians and physicians and nurses working at the first medical contact emergency department to which patients were initially admitted. The primary end-points of this study were to evaluate the role of first medical contact emergency departments and ambulance type on pain-to-balloon time. Secondary end-points were to define the current patient transport chain system in the city (İstanbul, Turkey) and propose solutions that could shorten AMI patient transport duration.

Variables

Diagnosis of acute MI was based on typical chest pain for at least 30 minutes, ST segment elevation ≥0.1 mV in at least 2 related electrocardiogram leads.

Pain-to-balloon time was defined as the time interval between the onset of symptomatic chest pain and balloon dilatation of the culprit lesion in the infarct related coronary artery.

Door-to-balloon time was defined as the time interval between entrance of the patient from emergency department of PCI capable center and balloon dilatation of the culprit lesion in the infarct related coronary artery.

First contact-to-balloon time was defined as the time interval between first medical contact of the patient and balloon dilatation of the culprit lesion in the infarct related coronary artery. Diabetes mellitus (DM) was defined according to patient medical histories, use of insulin or anti-diabetic agents, or a fasting glucose level > 126 mg/dL.

Hypertension (HT) was defined as the previous use of antihypertensive medications, a systolic pressure >140 mmHg, or a diastolic pressure >90 mmHg for at least 2 separate measurements. Smoking was defined as the current regular use of cigarettes and cigars.

First medical contact emergency departments were further categorized as follows: local daily-clinics, which usually provide outpatient healthcare; public hospitals; and private hospitals.

Ambulances were defined as either private or public.

PCI capable centers defined as center who perform >36 primary PCIs and also >400 total PCI in a year according to guidelines (12).

Statistical analysis

Statistical analyses were performed using SPSS 15.0 (SPSS Inc., Chicago, IL, USA) software. Descriptions of the parameters

are presented as the mean±SD and 95% confidence intervals (CI). The unpaired t-test was used for analysis of continuous variables between groups. Categorical variables were compared using the Chi-square and the Pearson's test for two independent samples. Comparisons of first admission centers and ambulance transport modalities were made using Kruskal-Wallis and Mann-Whitney U tests. All p values were two-sided in tests and p values < 0.05 were considered to be statistically significant.

Results

Baseline characteristics

The baseline demographics and clinical characteristics of the patients included in this study are summarized in Table 1. The mean patient age was 54.4±11.2 years, and ranged from 25 to 83 years of age: 81.3% of the AMI patients (304 patients) were male. Although the majority of the patients (88.2%) did not have a prior medical history of coronary interventions or coronary heart disease, half were diagnosed with HT and 23.5% of the patients had DM. Most of the patients were heavy smokers, consistent with the male predominance in the study group. A majority of the AMI patients were initially admitted to either a public (40.1%) or private (47.1%) hospital as their first medical contact centre. Only 5% of the patients were transported to emergency departments in an ambulance, and this small group of patients also did not experience shortened pain-to-balloon time, because they were often transported to PCI incapable centers. The rest of the patients (95%) went to their first medical contact centre without the use of an ambulance and without contacting their healthcare provider. The mean duration from chest pain-to-first medical contact centre was 126.7±123.0 min. Average door-to-balloon times were 45.0±18.5 min and mean pain-to-balloon times were 310.6±160.8 min.

Table 1. Baseline demographic characteristics, presentation, transport durations of the patients

Variables	
Age, years	54.4±11.2
Range;	25-83
Sex, % (n)	
Male	81.3 (304)
Female	18.7 (70)
Presence of diabetes mellitus, % (n)	23.5 (88)
Presence of hypertension, % (n)	48.7 (182)
Previous coronary intervention, % (n)	11.8 (44)
Current smoking, % (n)	61.5 (230)
First medical contact, % (n)	
Daily clinics	12.8 (48)
Public hospital	40.1 (150)
Private hospital	47.1 (176)
Transport to PCI-capable center, % (n)	
Public ambulance	49.2 (184)
Private ambulance	45.5 (170)
Cars of patients	5.3 (20)
Duration to first contact, min	126.7±123.0
Duration to PCI-capable centre, min	265.5±156.0
Door-to-balloon time, min	45.0±18.5
Pain-to-balloon time, min	310.6±160.8
First contact-to-PCI-capable duration, min	138.4±96.9
First contact-to-balloon time, min	186.6±104.3

Data are presented as mean±SD and number (percentage)
PCI - primary coronary intervention

Effects of first presentation site

There was a statistically significant difference in transport duration from first medical contact to PCI-capable centers and also in pain-to-balloon time with respect to the site of first presentation. Nearly half of all patients initially admitted to daily clinics as their first medical contact centre were usually then transported to PCI incapable centers, leading to delayed first admission to PCI-capable centers and increased pain-to-balloon time. Although patients admitted to daily clinics had shorter pain-to-first contact times (75.6±59.9 min, p=0.01), they experienced the longest first contact-to-PCI-capable centre times and pain-to-balloon times (220.3±157.2 and 361.7±194.5 min, p<0.001 and p=0.01 respectively). In contrast, patients initially admitted to private hospitals experienced relatively short first contact to PCI centre and pain-to-balloon times (113.2±72.5 and 277.5±148.6 min; p<0.001 and p=0.01, Table 2).

Effects of transport type

Private hospitals usually transport patients by private ambulance, while public hospitals usually prefer public ambulances for patient transport. Daily clinics sent patients to PCI-capable centers by both public and private ambulances, and also by private cars. Patient transport by private ambulance was associated with shorter first contact to PCI-capable centre times and shorter pain-to-balloon times (107.4±70.4 and 270.1±150.4 min; p<0.001, Table 3).

Discussion

Many AMI patients experience prolonged prehospital transport delays associated with higher mortality and morbidity. With this study, we demonstrated that, first medical contact side and transport manner may also prolong prehospital delay including pain-to-balloon times and first contact-to-balloon times besides factor associated with patients themselves. Patients admitted to daily clinics initially and who transported with public ambulance system showed relatively longer pain-to-balloon times and first contact-to-balloon times due to irregularities in the transport chain.

Mortality from AMI remains high, with most deaths occurring before hospital admission.

Table 2. Demographic and clinical characteristics, transport chains duration according to first admission site

Variables	Daily clinics (n=48)	Public hospital (n=150)	Private hospital (n=176)	Chi-square*	p*
Age, years	53.7±11.0 54.5 (35.0-80.0)	59.7±10.8 57.0 (41.0-83.0)	54.3±10.9 53.0 (25.0-80.0)	17.1	0.01
Sex, % (n)				7.0	0.03
Male	70.8 (34)	78.7 (118)	86.4 (158)		
Female	29.2 (14)	21.3 (32)	13.6 (24)		
Presence of diabetes mellitus, % (n)	25.0 (12)	28.0 (42)	19.3 (34)	3.4	0.17
Presence of hypertension, % (n)	29.2 (14)	64.0 (96)	40.9 (72)	25.5	<0.001
Previous coronary intervention, % (n)	8.3 (4)	17.3 (26)	8.0 (14)	7.4	0.02
First medical contact, % (n)				21.0	<0.001
On-time	45.8 (22)	36.0 (54)	61.4 (108)		
Off-time	54.2 (26)	64.0 (96)	38.6 (68)		
Transport to PCI-capable centre, % (n)				259.0	<0.001
Public ambulance	58.3 (28)	96.0 (144)	6.8 (12)		
Private ambulance	29.2 (14)	2.7 (4)	86.4 (152)		
Cars of patients	12.5 (6)	1.3 (2)	6.8 (12)		
Sequence of PCI-capable centre, % (n)				80.4	<0.001
Second line	41.7 (20)	86.7 (130)	94.3 (166)		
Third line	58.3 (28)	13.3 (20)	5.7 (10)		
Duration to first contact, min	75.6±59.9 60.0 (15.0-240.0)	141.6±123.6 90.0 (15.0-540.0)	128.0±131.7 60.0 (30.0-570.0)	13.4	0.01
First contact-to-PCI capable centre, min	220.3±157.2 150.0 (30.0-540.0)	141.9±81.2 120.0 (30.0-420.0)	113.2±72.5 90.0 (30.0-420.0)	38.0	<0.001
Door-to-balloon time, min	50.8±22.2 50.0 (20.0-90.0)	46.5±13.6 45.0 (20.0-80.0)	42.2±20.5 40.0 (15.0-90.0)	11.7	0.01
Pain-to-balloon time, min	361.7±194.5 330.0 (120.0-710.0)	333.0±155.4 272.5 (120.0-720.0)	277.5±148.6 230.0 (40.0-720.0)	14.4	0.01
First contact-to-balloon time, min	279.7±158.2 210.0 (90.0-590.0)	190.6±85.3 167.5 (60.0-480.0)	157.4±83.1 140.0 (65.0-465.0)	44.1	<0.001

Data are presented as mean±SD, median (interquartile range) and percentage (number) values
*Kruskal-Wallis test
PCI - primary coronary intervention

Table 3. Transport chain durations according to ambulance type

Durations, min	Public ambulance (n=184)	Private ambulance (n=170)	p*
First contact-to-PCI capable center	169.1±108.9 125.0 (30.0-540.0)	107.4±70.4 90.0 (45.0-480.0)	<0.001
First contact-to-balloon time	217.8±115.9 180.0 (60.0-590.0)	151.2±78.9 130.0 (65.0-510.0)	<0.001
Pain-to-balloon time	348.6±163.7 285.0 (120.0-720.0)	270.1±150.4 220.0 (39.0-720.0)	<0.001

Data are presented as mean±SD and median (interquartile range) values
*Mann-Whitney U test
PCI - primary coronary intervention

Within the last decade, morbidity and mortality from AMI has declined, due to earlier diagnosis and improved treatments (13). In particular, mechanical reperfusion with PCI has been shown to be superior to fibrinolysis at restoring flow to infarct related arteries. Therefore, transfer of AMI patients to PCI capable centers is preferred over fibrinolytic therapy (14, 15). In addition, reperfusion strategies in AMI patients are time-dependent and are more beneficial if applied within two hours of initial symptoms. In fact, it has been shown that treatment delays, even within the hospital, are associated with increased mortality and morbidity (16). Although the identification of factors affecting treatment times and methods to eliminate or minimize these treatment delays remains a major area of AMI research, most investigations have only focused on ways to decrease the door-

to-balloon time (17-20). As a result, door-to-balloon times have decreased from 120 minutes to 90 minutes (12). There are still ongoing investigations focusing on ways to reduce this time period even more. In our investigation, the mean door-to-balloon time was 45 minutes, in accordance with recent studies. However, the time elapsed between chest pain-to-first contact and first contact-to-treatment still remains excessive in most regions (21-24). In Turkey, to date, no investigations into the medical transport-chain and transport durations have been conducted. In addition, it was recently reported that the development of city-wide transport protocols and the establishment of hospital networks could shorten pain-to-balloon time in some countries (25-30). In contrast, in Turkey, no transport-chain protocol has been proposed by the municipality or health ministry. And also, percentage of primary PCI is about 10% in Turkey (31). Because of this lower ratio, Turkey was included to ''stent for life'' project proposed by European Society of Cardiology and supported by Turkish Society of Cardiology and Turkish Health Ministry (31, 32). This project was aimed to increase primary PCI in AMI patients and region with lowest percentage of primary PCI was usually included to project. Istanbul was not included to this project because of numerous primary PCI capable centers and relatively high percentage of primary PCI. Despite the numerous primary PCI capable centers, prehospital delay and transport chain system were not evaluated enough in the Istanbul. Norgaz and et al. (33) had investigated prehospital delay in the Asian side of İstanbul and they found mean 255 minutes prehospital delay in AMI patients which was parallel to our results (265 minutes). But, they did not evaluated transport system and they only revealed determinants of prehospital delay according to demographic characteristics of patients (33).

Most of the PCI-capable centers are located in a few crowded cities. İstanbul is one of the most crowded cities in Turkey and has many PCI capable cardiac centers: more than East region of the country. Thus, AMI patients in Istanbul have various admission and transportation modalities available, and it should be easy to reach a PCI capable centre in a short time period. We conducted our investigation on three well-known PCI-capable centers in İstanbul, Turkey. All three are referral centers in the region, enabling us to evaluate the medical transport chain more accurately. Our results demonstrate that there is no consensus between emergency departments at first medical contact centers. Daily clinics are small clinics which mostly care for ambulatory patients. They are prevalent even in small villages, so most people prefer them to health centers. Although AMI patients admitted to these clinics experienced relatively shorter pain to first contact times, these groups had to endure the longest pain-to-balloon times, because they were often first transported to PCI-incapable centers. Public hospitals were usually preferred by patients with previous chronic diseases as a first admission centre. Although 86.7% of patients initially admitted to public hospitals were transported to PCI capable centers, they still experienced longer pain-to-balloon times compared to patients originally admitted to private hospital centers. Because public hospitals mostly use the city ambulance system (96%) for transport of patients, this could be the reason for the observed increased pain-to-balloon times. Although all public hospitals have their own ambulances, they usually use vehicles from the city ambulance system, which is located in a specific region. In addition, city ambulances are commanded to direct patients to public hospitals for initial admission. For these reasons, use of the city ambulance system could prolong patient transport by at least 30 minutes. Moreover, 13.7% of AMI patients initially admitted to public hospitals were transported to PCI incapable regional state hospitals, due to a lack of communication between first contact emergency departments and the ambulance, leading to a further increase in pain-to-balloon times. The best results were observed for AMI patients initially admitted to private hospitals. These patients experienced shorter transport durations, pain-to-balloon times and even door-to-balloon times. This decrease in overall treatment delays could be the result of improved organization at the initial admitting hospital. Direct communication between emergency departments, ambulances, and the PCI-capable centre prior to admission could result in shorter door-to-balloon times, and also shorter first contact-to-balloon and pain-to-balloon times. In addition, private hospitals usually use their own ambulances for patient transport (86%), which could be another reason for the shorter pain-to-balloon times observed in this study. Our results indicate that daily clinics should be supervised and trained for AMI patient evaluation and admission, because they send nearly half of the AMI patients to PCI incapable centers. An improved transport chain sequence should be developed, especially for public hospitals. Use of on-site hospital ambulances, instead of the city ambulance system, could significantly decrease the pain-to-balloon time. Redirection of ambulances directly to more closer private primary PCI-capable centers by public ambulance physicians instead of the public hospital could also decrease pain-to-balloon times. In fact, although it was reported that direct transport of patients to primary PCI-capable centers by paramedics did not change the mortality rate, it could shorten the pain-to-balloon time. Direct admission of AMI patients at any PCI-capable centre, instead of centers located on the medical transport-chain, could decrease pain-to-balloon times, leading to salvage of more myocardial tissue (34, 35). Our results also indicate that transport duration using private ambulances and initial admission at private hospitals is associated with relatively shorter pain-to-balloon times. However, further development of definitive networks between private hospitals could decrease this treatment delay even more. Furthermore, our results also indicate the longer prehospital time period which consider the alternative treatments. Prehospital fibrinolysis is one of the proven reperfusion methods which could be performed in the ambulance (12). Fibrinolytic treatment could be performed only in the specific cases in which the cardiologists themselves accompany the patient transport. So, training of

ambulance's physician and settle of fibrinolytic agents to ambulances could improve the reperfusion in the AMI patients.

Study limitations

Major limitations of this study include the evaluation of patients living in a distinct region. Thus, our results do not reflect rural areas, or the whole country. However, our findings clearly demonstrate the significant influence of first contact emergency departments and ambulances on the transport chain of AMI patients, in a region where redundant PCI-capable centers are available for admission.

Conclusion

Early diagnosis and treatment is crucial in the AMI. Pain-to-balloon time is one of the reliable parameter regarding early and effective treatment. Duration of time to first medical contact constitutes major part of pain-to-balloon duration. In addition, first medical contact site and type of transport may also affect this duration. Patient admitted to daily clinics had a longer pain-to-balloon time and first contact-to-balloon times due to prolonged transport chain. On contrary, patients admitted to private hospitals experienced relatively shorter average pain-to-balloon times and first contact-to-balloon times. Patients transported by private ambulances also experienced relatively shorter waiting times and shorter pain-to-balloon times.

Clinical implications

Although door-to-balloon times have shortened progressively over the years, the time duration between onset of symptoms and transport of AMI patients to PCI-capable centers remains long. Physicians and healthcare professionals working in first contact emergency departments and ambulances appear to be factors affecting pain-to-balloon time and treatment delays. Improved training of these departments and the implementation of a city-wide transport chain system could decrease transport duration and pain-to-balloon times in AMI patients.

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