Research Article

Interventional Cardiology

Achieving the Recommendations of International Guidelines in ST-elevation Myocardial Infarction Patients after Start of an Off-Site Percutaneous Coronary Intervention Centre and a Network Focus Group: More Attention Must be Paid to Pre-Hospital Delay

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Objective: Delays in the treatment of patients with ST-segment elevation myocardial infarction (STEMI) are still substantial and achieving the guideline recommendations is challenging. Specifically pre-hospital delays, including general practitioner (GP) and emergency medical transport (EMT) receive little scientific attention. Our objective is to achieve the international guideline recommendations for pre-hospital delay in STEMI patients.

Methods: This is a prospective, observational, cohort study evaluating the delays of STEMI patients. To diminish delays within the studied region an off-site percutaneous coronary intervention (PCI) centre and an acute coronary syndrome focus group comprising the Cardiology Departments, EMT service and GPs were set up. Delays before and after the start of the off-site PCI centre and focus group were analysed.

Results: The median system delay (from any first medical contact to start of PCI) significantly decreased from 80 to 65 minutes. Median electrocardiogram-to-PCI delay decreased from 64 to 48 minutes. The percentage of patients with a system delay <90 minutes improved from 73% to 85% and the percentage with an electrocardiogram-to-PCI delay <90 minutes improved from 92% to 96%. GPs play an important role within the STEMI network with 45% of the patients contacting the GP first, resulting in a slight increase in delays compared to EMT as first medical contact.

Conclusion: The guideline recommendations are achieved within the studied region after start of an off-site PCI centre and a focus group including Cardiologists, GPs and EMT service, demonstrating that focussed attention can effectively result in a decrease in pre-hospital delays.

Keywords: STEMI ▪ General practitioner ▪ Percutaneous coronary intervention ▪ Emergency medical services

Introduction

Delays in the treatment of patients with ST-segment elevation myocardial infarction (STEMI) should be kept as short as possible to limit extend of necrosis and to decrease the risk of heart failure and mortality [1,2]. Percutaneous coronary intervention (PCI) is

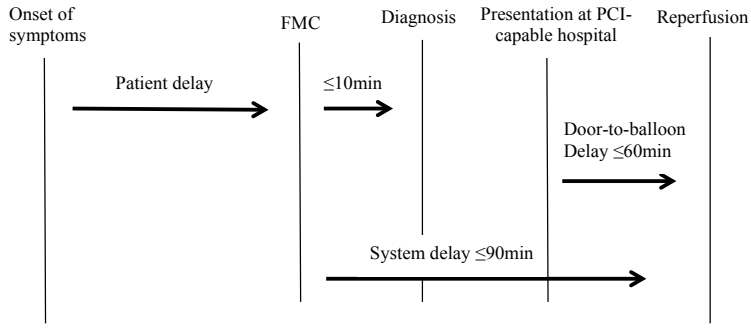

Figure 1 Guideline recommended delays. (FMC: first medical contact; any contact with a paramedic about cardiac symptoms, PCI: percutaneous coronary intervention, min: minutes).

the preferred reperfusion therapy in STEMI patients, if performed within guideline recommended timeframes. The guidelines advise that at least 90% of STEMI patients should have a system delay of 90 minutes or less. Other recommended delays are depicted in Figure 1 [3].

Despite decreased door-to-balloon as well as diminished emergency medical transport (EMT) delays [4], the recommendations in the guidelines are rarely met [5,6]. Most studies define the FMC as first ECG [1,7-9], neglecting the time from first call to the arrival of a paramedic or general practitioner (GP) and the triage of the EMT service. Contacting a GP first can increase the delay in reperfusion up to 95 minutes [10] and as studies report that 37% to 75% of STEMI patients contact a GP [11,12]; this is an important point of focus. It is recommended that the entire network involved in triage, transport and treatment of STEMI patients should work closely together [7,13].

To meet the increased demand of PCIs and to decrease the pre-hospital delays a focus group comprising of the Cardiology departments, EMT service and GPs was set up and an off-site PCI centre was started [14]. Off-site PCI centres, with no surgical back-up in the own hospital, have been proven to be safe [15,16], if they have high operator and intuitional volumes [17]. This study evaluates the effect of starting an off-site PCI centre and a focus group on the delays of STEMI patients.

Methods

Study design

This study is a prospective, observational, cohort study. To achieve the recommended delays in STEMI patients from North and Middle Limburg, the Netherlands, the Cardiology departments, EMT service (Ambulance Zorg Limburg Noord), and GPs (Cooperation Cohesie), set up the Acute Coronary Syndrome-Limburg North (ACS-LN) focus group. This focus group designed a protocol for the assessment and treatment of ACS patients (Supplementary Figure 1). They devised a questionnaire requesting time points in the STEMI network, filled in by EMT personnel, to evaluate the delays and protocol use. To limit the influence of human error, time stamps were used as much as possible. Data from patients, who were referred directly to the emergency department (ED), without any use of EMT, were retrospectively retrieved from the medical files. The system delay was defined as FMC to the start of the PCI procedure. The FMC was any contact with a paramedic about cardiac symptoms, including GPs, EMT and the ED.

The mortality of the study population was compared to the Thrombolysis in Myocardial Infarction (TIMI) risk score study [18].

Setting and population

All consecutive patients with a STEMI from North Limburg referred to a PCI-capable centre for primary PCI were included from June first 2011 until November first 2015. Until September 2013 the STEMI patients were referred to Catharina Hospital Eindhoven, the Netherlands, at that time the closest primary (on-site) PCI-capable hospital. In September 2013 VieCuri Medical Centre Venlo, the Netherlands, started as an off-site PCI centre, bypassing the 60 km transport of STEMI patients. This off-site PCI centre performs more than 1200 PCIs per year. The patient group who underwent their PCI at Catharina Hospital Eindhoven (the on-site group) and the patient group who underwent their PCI at VieCuri Medical Centre Venlo (the off-site group) all came from the same region (North Limburg), therefore the results given are not a representation of the system delay of Catharina Hospital Eindhoven.

Patients with an out-of-hospital resuscitation were

excluded. STEMI patients treated with shocks for ventricular tachycardia or fibrillation from the EMT and/or hospital with rapid conscience recovery were included.

Statistical analyses

All data were collected by an independent investigator and analysed with SPSS version 22. The categorical data are presented as number of patients and percentages. Continuous data are presented as means and standard deviations (SD) in case of normally distributed data and as medians and interquartile ranges (IQR) in case of skewed data. Patients with (some) missing data were included for analysis of non-missing values. Missing data were not replaced and are given per variable in the tables. The Student t-test was used for normally distributed continuous variables and the Mann-Whitney U-test was used for skewed distributed continuous variables. Categorical variables were analysed using a chi-square test. To check for possible confounding we analysed whether baseline variables that differed between the two groups (on-site and off-site group) correlated with the delays using the Pearson's correlation coefficient.

A p-value of less than 0.05 was considered significant.

Results

Baseline

A total of 227 patients were included from June first 2011 until September first 2013 who were referred to Catharina Hospital Eindhoven for primary PCI (the on-site group) and 339 patients were included from September first 2013 until November first 2015 who were referred to VieCuri Venlo (the off-site group). Baseline characterisations are presented in Table 1. Gender, presentation during office hours, mortality and TIMI score were not significantly different between the groups. The patients referred to the off-site centre were significantly older (63 years and 62 years respectively), though there was no correlation found between age and the delays.

The FMC of the patients did not differ significantly between the two groups (Figures 2 and 3).

Guidelines adherence

The system delay, i.e. FMC to start PCI, significantly decreased from 80 minutes to 65 minutes. The delay

Table 1 Baseline characteristics

	On-site	Off-site	P-value
Study population, n	227	339	-
Male gender, n (%)	164 (72,2%)	239 (70,5%)	0,653
Age, years (SD)	62,0†(13,8)	63,3†(12,7)	0,036
Presentation during office hours, n (%)	76 (35,5%)	133 (39,5%)	0,160
Mortality 30 day, n (%)	6 (2,6%)	7 (2,1%)	0,578
TIMI score, (IQR)	2,2*(5,7)	2,2*(5,7)	0,310

TIMI: Thrombolysis in Myocardial Infarction risk score, SD: standard deviation
*median,
†mean

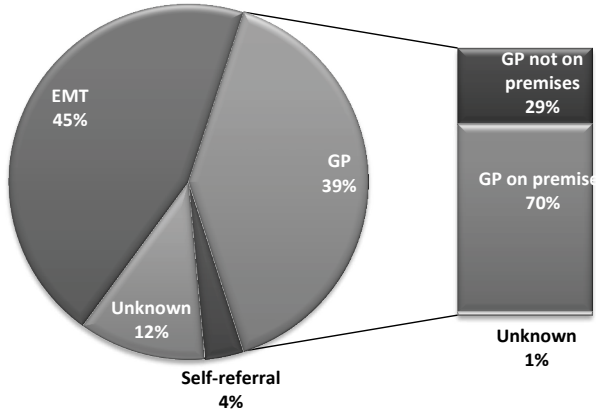

Figure 2 First medical contact of patients to (para)medic in the on-site group. (n = 227 EMT: emergency medical transport, GP: general practitioner**)**

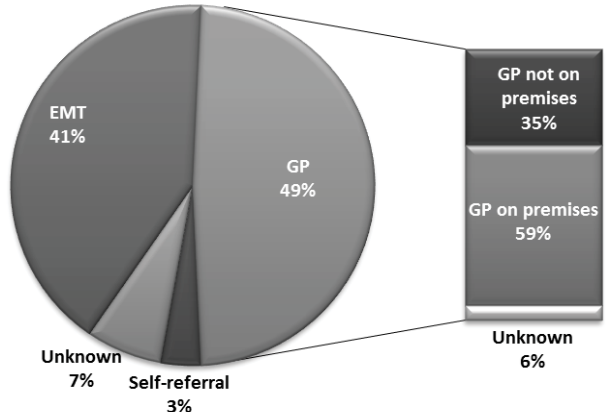

Figure 3 First medical contact of patient to (para) medic in the off-site group. (n=339 EMT: Emergency Medical Transport, GP: General Practitioner**)**

Table 2 Delays

	On-site	n (missing)	Off-site	n (missing)	P-value
System delay: FMC until PCI start, min (IQR)	80*(20)	131 (96)	65*(25)	265 (74)	<0.001
Percentage FMC until PCI start <90 min	73.3%	131 (96)	85.3%	265 (74)	0.004
ECG until PCI start, min (IQR)	64*(19)	147 (37)	48*(19)	302 (37)	<0.001
Percentage ECG until PCI start <90 min	89.1%	147 (37)	93.0%	302 (37)	0,155
ECG until Cath lab, min (IQR)	55*(18)	195 (32)	39*(22)	298 (41)	<0.001
GP					
Call-to-GP until GP- call-to-EMT, min (IQR)	5*(18)	63(19)	5*(19)	84 (53)	0,447
Call-to-GP until GP-call-to-EMT with GP on premises, min (IQR)	10*(24)	40 (17)	9*(23)	50 (35)	0,523
Call-to-GP until ECG diagnosis, min (IQR)	20*(20)	65 (17)	25*(20)	85 (52)	0,206
EMT					
Call-to-EMT until ambulance arrival, min (SD)	8†(3)	147 (31)	9†(4)	264 (6)	<0.001
Call-to-EMT until ECG diagnosis, (IQR)	13*(6)	153 (25)	15*(8)	243 (27)	<0.001
Departure-to- and arrival-at-Cath lab, (IQR)	35*(10)	140 (38)	22*(15)	252 (18)	<0.001
Patient delay					
Patient delay: symptom onset to FMC, min (IQR)	47*(98)	161 (66)	58*(190)	237 (102)	0,096
Patient delay when FMC is GP, min (IQR)	67*(141)	66 (25)	74*(207)	96 (69)	0,337
Patient delay when FMC is not GP, min (IQR)	32*(76)	95 (15)	42*(163)	141 (10)	0,098

Values are minutes or n
FMC: first medical contact; any contact with a (para)medic about cardiac symptoms, PCI: percutaneous coronary intervention, ECG: electrocardiogram, Cath lab: catheterization laboratory, IQR: interquartile range, GP: general practitioner, EMT: emergency medical transport
*median
†mean

between ECG diagnosis to the start of the PCI procedure, was also significantly lower in the off-site group (Table 2).

Patients contacted the GP more often in the off-site group than in the on-site group, namely 49% *vs.* 39%, although this difference was not significant. The delays associated with the GP did not differ either. The EMT delay, i.e. the time from calling the EMT until ambulance arrival, did increase from 8 to 9 minutes (Table 2). When comparing FMC as GP *vs.* FMC as EMT over the whole group (on- and off-site groups combined) the system delay was 68 min *vs.* 75 min (p=0,012).

The off-hour presentation was not different between the groups and is therefore presented for both groups together. The overall delay in the off-hours did not significantly differ from the delay during daytime. Moreover the GP delay also did not differ between off-hours and daytime (Table 3).

Patient delay

The median patient delay was longer in the off-site

Table 3 Off-hour presentation delay

	Off-hour	n (missing)	On-hour	n (missing)	P-value
System delay, min (IQR)	70*(24)	250 (104)	72*(35)	146(63)	0,915
System delay with FMC is GP, min (IQR)	75*(35)	84(48)	77*(38)	79(44)	0,968

Values are minutes or n
FMC: first medical contact; any contact with a (para)medic about cardiac symptoms, GP: general practitioner, IQR: interquartile range
*median

group, although this difference was not significant (Table 2). The mean delay of the groups combined is almost 3 h (170 minutes) with 6% of the patients waiting more than 12 h before contacting a paramedic.

Patients contacting the GP waited significantly longer to contact a paramedic, than patients contacting the EMT directly.

Discussion

The most important finding in our study is that the guideline recommended system delays in STEMI patients were achieved. With the close collaboration of the entire ACS network involved in triage, transport and treatment of STEMI patients and the start of an off-site PCI centre the delay in STEMI patients has decreased. The system delay in our region from any FMC to initiation of PCI is 68 minutes, a much lower delay than reported in other studies [2,5,19]. Most studies moreover report ECG to initiation of PCI as system delay, varying from 60 to 210 minutes [7,20]. In our study we achieved a median ECG to initiation of PCI delay of only 48 minutes.

The percentage of patients with a system delay of 90 minutes or less also improved significantly from 73% to 85%, and thus the target of 90% is almost reached. When using the more frequently applied definition of system delay, from ECG to initiation of PCI, more than 90% of the patients are treated within 90 minutes, thereby reaching target. This is much higher than the 22% to 82% reported in other studies [5-8]. The mortality and TIMI scores of the two groups were identical and, as published before, the occurrence of procedural complications and MACE were low with no significant differences [21].

General practitioner

The findings in our study show that patients contacted the GP frequently with 39% in the on-site group and 49% in the off-site group, a non-significant difference. This is comparable to previous studies with 37 to 75% of the STEMI patients consulting the GP [10-12]. Within the study period the number of GP visits decreased over time: the GPs visited 74% of the patients who contacted the GP in the on-site group (from June first 2011 to September first 2013) and only 59% of the patients in the off-site group (from September first 2013 to November first 2015). This (non-significant) decrease might be due to the recent recommendation of the cardiac guidelines that STEMI patients should bypass the GP when experiencing chest pain [3].

The system delay was slightly, though significantly, longer when the GP was consulted first rather than the EMT (68 *vs* 75 min). These delays are lower than the delays in other studies [11,12]. Which might be a consequence of the recommendation within the cardiac guidelines to diminish GP participation within the network [3,22]. To advise all patients with chest pain to contact the EMT, and thus bypassing the GPs entirely in the STEMI network is not feasible, as not all patients with chest pain have a STEMI or even ACS. Up to 80% of the patients within the primary care setting with chest pain do not have ACS and therefore without GP triage the EMT and hospitals would be overcrowded [23].

As this study shows that the guidelines can be achieved with GP involvement, we recommend regular meetings with all participants in the ACS network including Cardiology departments, EMTs and GPs to improve the delays in STEMI patients, but not dismiss GPs from the ACS network.

Emergency transport delay

The EMT delay was low with 8 and 9 minutes response time, well within the recommended target of 15 minutes [24]. Although the one minute increase was statistically significant, it is unlikely to be clinically relevant. Possible explanations of this difference could be the changes in shift hours and ambulance locations during the study.

Off-hour presentation

Off-hour presentation of STEMI patients is reported

to be associated with longer delays and higher mortality [25]. In our study, off-hour presentation did not result in significant longer delays. Off-hour presentation to a GP also did not significantly delay PCI. Studies suggest that the delaying factor of off-hour presentation can be improved with a multidisciplinary and protocol driven network with a high-volume PCI-centre [26,27], as is the case in our region.

Patient delay

The above mentioned delays are all organization related delays; however a crucial part of the pre-hospital delay includes patient delay. In this study we have found median patient delays of 47 and 58 minutes, a non-significant increase and lower than reported in previously published studies [28,29]. However a small group of patients waited more than 12 h making the mean delay almost three hours, a substantial delay which needs to be diminished.

Patients contacting the GP, waited longer to call for help, than patients contacting the EMT. Patients contacting the GP might have less typical symptoms, not recognize a heart attack and thus not contact the EMT immediately. This could increase the GP delay as well, as it is more difficult to diagnose these patients.

Reducing the patient delays has proven to be complex, with most studies not leading to a reduction of the delays [29,30]. The patient delays depicted in this study are much lower than the earlier studies and comparable to other, more recent studies [19]. There may be improvements within patient delay that have already taken place, such as increased awareness. However, as any delay increases the risks and some patients wait more than twelve hours, these delays are too long, and should still be a point of focus.

Conclusion

This study shows that the delays of STEMI patients can be improved by focussing on pre-hospital delays and thus achieving the recommended delays in the guidelines. The guideline recommendations are met within the studied region after the start of an off-site PCI centre and with a multidisciplinary and protocol-driven network, including the Cardiology departments, GPs and EMT service.

Strengths and Limitations

The strength of our study is that we included the FMC to any (para) medic, as most other studies do not report the pre-hospital delays before ECG. Missing data, mainly due to handwritten forms, are a limitation. Patients with a STEMI but not referred to the hospital are not part of this study. Patients with out-of-hospital resuscitation were excluded, however these patients also benefit of decreased delays and more research should be conducted within this group.

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Conflict of Interests

None declared

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