Reperfusion delay in patients treated with primary percutaneous coronary intervention: insight from a real world Danish ST-segment elevation myocardial infarction population in the era of telemedicine

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Abstract

Background: Reperfusion delay in ST-segment elevation myocardial infarction (STEMI) predicts adverse outcome. We evaluated time from alarm call (system delay) and time from first medical contact (PCI-related delay), where fibrinolysis could be initiated, to balloon inflation in a pre-hospital organization with tele-transmitted electrocardiograms, field triage and direct transfer to a 24/7 primary percutaneous coronary intervention (PPCI) center.

Methods and results: This was a single center cohort study with long-term follow-up in 472 patients. The PPCI center registry was linked by person identification number to emergency medical services (EMS) and National Board of Health databases in the period of 2005–2008. Patients were stratified according to transfer distances to PPCI into zone 1 (0–25 km), zone 2 (26–100 km) and zone 3 (101–185 km) and according to referral by pre-hospital triage. System delay was 86 minutes (interquartile range (IQR) 72–113) in zone 1, 133 (116–180) in zone 2 and 173 (145–215) in zone 3 ($p < 0.001$). PCI-related delay in directly referred patients was 109 (92–121) minutes in zone 2, but exceeded recommendations in zone 3 (139 (121–160)) and for patients admitted via the local hospital (219 (171–250)). System delay was an independent predictor of mortality ($p < 0.001$).

Conclusions: Pre-hospital triage is feasible in 73% of patients. PCI-related delay exceeded European Society of Cardiology (ESC) guidelines for patients living >100 km away and for non-directly referred patients. Sorting the PPCI centers catchment area into geographical zones identifies patients with long reperfusion delays. Possible solutions are pharmaco-invasive regimens, research in early ischemia detection, airborne transfer and EMS personnel education that ensures pre-hospital triage.

Keywords

Acute myocardial infarction, STEMI, primary PCI, pre-hospital triage, reperfusion delay, telemedicine

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Introduction

In patients with ST-segment elevation myocardial infarction (STEMI) treated with primary percutaneous coronary intervention (PPCI), reperfusion delay predicts the extent of salvaged myocardium,¹ final myocardial infarct size,² chronic heart failure (CHF)³ and long term mortality.⁴ Guidelines emphasize the need to minimize all time delays,

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especially within the first two hours of symptom onset.⁵ The implementation of telemedicine by pre-hospital 12-lead ECG recording and transmission to an attending cardiologist in a percutaneous coronary intervention (PCI)-capable center reduces system delay more than one hour by-passing local hospitals.⁶ However, marked system delay may still be the reality for patients redirected for PPCI by telemedicine. STEMI patients are at high risk of developing arrhythmic complications within the first hours of symptom onset,⁷ making safe ambulance transport pivotal. Proper identification of patients with expected long reperfusion delay seems important in order to foresee the need for early reperfusion alternatives to PPCI. This requires assessment of PCI-related delay, defined by European Society of Cardiology (ESC) guidelines⁵ as the time interval from first medical contact (FMC) where, at least in principle, reperfusion therapy could be given, to balloon inflation. Transfer distances in Denmark were estimated to be sufficiently short to replace fibrinolytic therapy by PPCI as a national reperfusion strategy after Danish Acute Myocardial Infarction-2 (DANAMI II), demonstrating that PPCI is superior to fibrinolytic therapy in patients treated within two hours of FMC.⁸

Experiences from established STEMI network systems that ensure ECG telemetry and bypass community hospitals and emergency rooms in PCI-capable hospitals, all show the feasibility of providing PPCI to the majority of the population and that systems of care improve clinical outcomes and their results have influenced guidelines. Nevertheless, not all patients referred for PPCI may receive optimal mechanical reperfusion (FMC to balloon <120 min).^{9–16}

Our main purpose was therefore to evaluate reperfusion delay by the objective time intervals of emergency medical services (EMS) alarm call to first balloon inflation (system delay) and PCI-related delay in the era of telemedicine for STEMI patients and to assess the influence of system delay on the safety of ground transfer and mortality.

Methods

Pre-hospital triage

Pre-hospital triage by telemedicine was started in the Copenhagen Region in 2002 and in Southern Zealand in 2005 and fully implemented in both regions at the beginning of the study period in May 2005. All included patients could therefore in theory be directly transferred from the injury scene to a PPCI center, by-passing local hospitals. Physician-manned Mobile Emergency Care Units (MECU) assisted on scene or were available for rendezvous, i.e. meeting the ambulance en-route to the PPCI center when transfer distances were substantial. This allowed advanced medical life support when necessary. The LIFEPAK 12 (Physio-Control, Inc., Redmond, Washington) defibrillator/monitor was used for transmitting the digital 12-lead ECG

through the global system for mobile communication (GSM) network to a receiving station located in the cardiac care unit. The on-call cardiologist interpreted the ECG and called the ambulance/MECU to conduct a short health personnel interview. In case of a likely STEMI diagnosis based on ECG and interview, the ambulance/MECU was re-routed directly to the pre-alerted catheterization laboratory. ECG STEMI criteria were ≥ 2 -mm ST-segment elevation in men and ≥ 1.5 mm in women in leads V2–V3 and ≥ 1 mm in ≥ 2 leads on all other leads.

Geographical area

Rigshospitalet's catchment area in the study period consisted of Copenhagen County (540,000 inhabitants, 90 km²), Storstroem County (262,781 inhabitants and 3398 km²) and Western Zealand County (307,207 inhabitants, 2983 km²). We chose Storstroem County as our study area because it geographically encompasses the farthest transfer distances (periphery 65–185 km) and compared it to Copenhagen County (zone 1) (0–25 km) as our control area. Study patients were divided in zones according to injury site. Storstroem County was arbitrarily divided at 100 km into zone 2 (Zealand South) (65–100 km) and zone 3 (Lolland Falster Islands) (101–185 km). Zone 1 has fast ground ambulance transfer, granted by the vicinity of a PPCI capable center and pre-hospital triage. Zones 2 and 3 comprised longer transfer distances and patients in whom a pre-hospital diagnosis was established by telemedicine but without necessarily direct referral for PPCI.

Study population

This was a single center cohort study of STEMI patients with follow-up. The inclusion period was 1 May 2005 to 31 January 2008. Ambulance/MECU charts held time information on alarm call, arrival at scene, departure from scene and hospital arrival, gathered in pre-hospital databases. We searched these databases from Storstroem County and Copenhagen County with the selection criteria of a tentative pre-hospital STEMI diagnosis. Identified patients were then compared to entries in our in-hospital procedural PPCI database, which holds baseline and PCI procedural characteristics, timepoints and outcome, information on patient recalled symptom onset and discharge diagnosis. Patients that figured in both a pre- and in-hospital database with an identical personal identification number, relevant diagnosis, identical transfer and treatment date, and relevant system time information represent the study population (Figure 1). False positive patients were excluded. Information on all-cause mortality and whether or not a patient initially was admitted to a local emergency room, were retrieved from databases provided by the Danish National Board of Health. Valid Cases were above 80% of the total patient population for all baseline

Figure 1. Map of Zealand, Denmark with geographical zones. Green: zone 1 (Greater Copenhagen Region (0–25 km)); Yellow: zone 2 (Southern Zealand (65–100 km)); Red: zone 3 (Island of Lolland-Falster (100–185 km)). STEMI: ST-segment elevation myocardial infarction; NSTEMI/UAP: non ST-segment elevation myocardial infarction/unstable angina pectoris.

variables except for family history of ischemic heart disease (IHD: 76.1%), dyslipidemia (63.1%), former myocardial infarction (MI: 60.4%) and body mass index (BMI: 39.6%). Regarding outcome variables, valid cases were above 80% of the total patient population except for patient delay (64.2%), PCI related delay (76.1%) and treatment delay (62.5%). The study was approved by the Danish Data Protection Agency (2011-41-5849) and The National Board of Health (7-505-29-1710/1/FSE).

Definitions of system time points

System time points were defined according to recent studies^{3,4,17,18} and ESC guidelines.⁵ Patient delay was defined as patient-recalled symptom onset to EMS alarm call ('alarm call' in the EMS chart refers to ambulance dispatchment time, when the EMS personnel enters the ambulance, which implies a few minutes delay after the proper alarm call); pre-hospital system delay as time from EMS alarm call to arrival at a primary PCI center; door to balloon as time from arrival at PCI center to balloon inflation; system delay

as time from EMS alarm call to balloon inflation; PCI-related delay as time from FMC to balloon inflation; treatment delay as time from symptom onset to balloon inflation.

Statistics

Statistical analysis compared zones 1, 2 and 3. Primary outcome measures were system and PCI-related delay. Secondary outcome measures were all cause long term mortality in association with system delay and complications during transfer. Continuous variables are presented as median with interquartile range (IQR). Discrete data are presented as frequencies and percentages. The χ^2 test, Fisher's exact test, Mann-Whitney test, and Kruskal-Wallis test were used for comparison of categorical and continuous variables as appropriate. In Cox regression analysis, mortality predictors were tested in an univariable model and only significant predictors were entered in a multivariable backwards stepwise model. The statistical significance level was $P < 0.05$ (two-sided test). Data were

Table 1. Baseline characteristics.

	Zone 1 (0–25 km) (n=238)	Zone 2 (65–100 km) (n=115)	Zone 3 (100–185 km) (n=119)	P value
Age	63 (54–71)	62 (54–72)	66.5 (56–73)	0.242
Male	174 (73.1)	89 (77.4)	90 (75.6)	0.525
Hypertension	73 (38.4)	40 (39.2)	34 (32.1)	0.323
Diabetes	23 (11.2)	9 (8.3)	11 (9.8)	0.629
Dyslipidemia	35 (25.5)	26 (32.5)	17 (21)	0.598
Family history of IHD	73 (41.5)	28 (30.8)	28 (30.4)	0.050
Current smoking	135 (67.5)	59 (56.7)	56 (54.9)	0.022
BMI	25.6 (23.2–29.3)	25.8 (23.3–28.4)	27 (24.6–30.3)	0.202
Prior MI	8 (9.1)	8 (14.5)	4 (9.1)	0.836
Prior PCI	17 (7.1)	8 (7)	9 (7.6)	0.903
Culprit				
LAD	98 (42.1)	51 (44.3)	55 (47)	0.375
LCX	33 (14.2)	18 (15.7)	14 (12)	0.654
RCA	98 (42.1)	46 (40)	48 (41)	0.812
LM	5 (2.1)	0 (0)	1 (0.9)	0.216
Anterior infarction	103 (46.4)	54 (47.4)	55 (47)	0.898
Multiple vessel disease	60 (25.2)	31 (27)	27 (22.7)	0.678
Acetylsalicylic acid	205 (91.1)	110 (96.5)	113 (95.8)	0.059
Clopidogrel	203 (90.2)	104 (91.2)	115 (97.5)	0.023
Heparin	157 (69.8)	111 (97.4)	113 (95.8)	<0.001
GP IIb/IIIa inhib.	127 (62.3)	91 (83.5)	88 (82.2)	<0.001
Bivalirudin	67 (32.8)	1 (0.9)	0 (0)	<0.001
Pre-procedural TIMI flow				
0	141 (59.7)	60 (53.1)	54 (47)	0.021
1	12 (5.1)	9 (8)	12 (10.4)	0.061
2	34 (14.4)	22 (19.5)	22 (19.1)	0.213
3	49 (20.8)	22 (19.5)	27 (23.5)	0.626
Post-procedural TIMI flow 3	213 (90.6)	104 (92)	104 (90.4)	0.793
Peri-procedural cardiogenic shock	14 (5.9)	2 (1.7)	3 (2.5)	0.081

BMI: body mass index; CABG: coronary artery bypass graft; IHD: ischemic heart disease; LAD: left anterior descending artery; LCX: left circumflex artery; LM: left main coronary artery; MI: myocardial infarction; PCI: percutaneous coronary intervention; RCA: right coronary artery; TIMI: thrombolysis in myocardial infarction; GP IIb/IIIa inhib.: glycoprotein IIb/IIIa inhibitor.

analyzed using the PASW Statistics software package, version 18 (SPSS, Inc., Chicago, Illinois, USA).

Results

We identified 472 patients with entries in both pre- and in-hospital databases, based on 238 cases in zone 1, 115 patients in zone 2 and 119 patients in zone 3. The groups were well-balanced in terms of baseline and procedural variables (Table 1). Pre-procedural thrombolysis in myocardial infarction (TIMI) 0 flow was significantly more frequent in zone 1 compared to zones 2 and 3 ($p=0.021$).

Temporal trends in diagnosis and referral

Time analysis is displayed in Table 2. System and PCI-related delay in zones 2 and 3 were significantly longer compared to zone 1 (<0.001) (Table 2 and Figure 2). Patients in zones 2 and 3 were sub-stratified according to direct or non-direct referral by pre-hospital triage. In zones 2 and 3, 80

(34%) patients were transferred to the PPCI center via a local hospital. Seventeen of these (7%) had presented themselves at the local hospital and were excluded from the time analysis presented in Figures 2 and 3, as self-presenters have not been in contact with the EMS at injury site and therefore cannot be subject to pre-hospital triage. This yielded 73% of patients with direct referral for PPCI. Patients with non-direct referral spent 70 (46–150) min at the local hospital. There was significantly prolonged PCI-related delay (219 min (171–250) vs 121 (106–149) (<0.001)) in the non-direct referral group vs the direct referral group (Figure 2). We explored the reasons for indirect referral in Figure 3. PCI-related delay was 109 min (92–122) in zone 2 and 139 min (121–160) in zone 3 for directly referred patients.

Transfer complications and mortality rates

The incidence ventricular fibrillation (VF)/ventricular tachycardia (VT)/asystole, AV-block $>2^{\text{nd}}$ degree, Killip Class 2–4, hypotension (systolic blood pressure (SBP) <100) and

Table 2. Median time intervals according to geographic zone 1–3.

	Median time intervals in minutes			P value
	Zone 1 (0–25 km) (n=238)	Zone 2 (65–100 km) (n=115)	Zone 3 (100–185 km) (n=119)	
Patient delay	41 (15–85)	75 (29–170)	52 (26–99)	0.009
Call to scene	6 (4–7)	17 (10–22)	14 (10–19)	<0.001
Time at scene	20 (15–25)	16 (8–22)	18 (12–23)	0.002
Scene to PCI center	9 (7–12)	60 (50–70)	91 (75–125)	<0.001
Door to balloon	45 (33–70)	30 (20–39)	30 (23–45)	<0.001
Pre-hospital delay	35 (29–43)	98 (82–129)	135 (110–173)	<0.001
PCI-related delay	79 (65–100)	119 (102–168)	160 (128–210)	<0.001
System delay	86 (72–113)	133 (116–180)	173 (145–215)	<0.001
Treatment delay	135 (100–200)	235 (158–350)	235 (187–330)	<0.001

PCI: percutaneous coronary intervention.

Figure 2. System delay (emergency medical services (EMS) call to balloon) and first medical contact (FMC) to first balloon inflation in minutes (median; interquartile range (IQR)) according to zones or direct/non-direct referral. IHF: in-hospital fibrinolysis; PCI: percutaneous coronary intervention; PHF: pre-hospital fibrinolysis.

tachycardia (heart rate >100) did not differ significantly between zones (Table 3). Mortality rates were analyzed for the first 24 hours, 7 days, 30 days and at final follow up (median 4.3 years). There were no significant differences in mortality rates at 7 days, 30 days or final follow up. In zone

1, there was a significantly higher mortality rate ($p=0.036$) during the first 24 hours after admittance to PPCI (Table 3). Tachycardia, hypotension, door-to-balloon and system delay were independent predictors of mortality at final follow up (Table 4).

Figure 3. Reasons for indirect referral in zones 2 and 3. Percentages are given for the overall population in zones 2 and 3 ($n=234$). Atrioventricular block (AV) $>2^{\text{nd}}$ degree. VF: ventricular fibrillation; VT: ventricular tachycardia.

Table 3. Complications during transfer and mortality rates.

	Zone 1	Zone 2	Zone 3	P value
VF/VT/asystole	18 (7.6)	12 (10.4)	14 (11.8)	0.178
SBT <100	49 (20.6)	11 (9.6)	18 (15.1)	0.092
Heart rate >100	33 (13.9)	21 (18.9)	14 (11.4)	0.736
AV block $>2^{\text{nd}}$ degree	4 (1.7)	4 (3.5)	2 (1.7)	0.842
Killip class 2–4	26 (11.8)	13 (12.5)	8 (7.8)	0.731
Mortality within 24 hours	10 (4.2)	1 (0.9)	1 (0.8)	0.036
Mortality within 7 days	16 (6.8)	4 (3.5)	5 (4.2)	0.239
Mortality within 30 days	19 (8.1)	7 (6.1)	8 (6.8)	0.501
Mortality at final follow up	56 (23.8)	23 (20)	20 (16.9)	0.126

AV: atrioventricular; SBT: systolic blood pressure; VF: ventricular fibrillation; VT: ventricular tachycardia.

Discussion

In this ‘real world’ registry study from a small homogenous area with implemented tele-transmission of digital ECG, field triage and direct transfer to a PCI-capable center around the clock, the main finding is that reperfusion is still delayed beyond current ESC recommendations (Table 2 and Figure 2).⁵ PCI-related delay in the overall population was borderline with regard to ESC guidelines (<120 min) for patients in zone 2 (119 min), but exceeded recommendations in zone 3 (160 min) (Table 2). Among patients transported by EMS from injury scene, 73% were field-triaged directly to PPCI. A recent study from Western Denmark found a practically identical proportion of 72%.¹⁸ The effectiveness of pre-hospital triage is highlighted by

219 min system delay among non-directly transferred patients (Figure 2). Seventy minutes were spent at the local hospital. In patients transferred by direct referral only, PCI-related delay was 109 min in zone 2 and 139 min in zone 3. Also in directly referred younger patients (<75 years) with anterior STEMI, PCI-related delay exceeded ESC guidelines (90 min) in zone 2 (113 min (118–210)) and zone 3 (144 min (124–159)).

PCI-related delay

Recently the ESC paradigm of an acceptable two hour limit from FMC has been disputed.^{17,19} Given a maximum acceptable PCI-related delay of 120 min (instead of

Table 4. Univariable and multivariable predictors for long term all cause mortality. Univariable and multivariable predictors for long term all cause mortality in the entire population. Hypertension, Hypercholesterolemia, diabetes, smoking status, former MI, AV block >2nd deg., patient delay, pre-hospital delay, door to balloon, treatment delay were also tested for univariable prediction but were non significant. In addition to significant univariable predictors, model 1 adjusts for door-to-balloon and model 2 for system delay.

	Univariable predictors		Multivariable predictors Model 1		Multivariable predictors Model 2	
	HR (95% CI)	p	HR (95% CI)	p	HR (95% CI)	p
Age (per year)	1.072 (1.053–1.091)	<0.001	1.066 (1.045–1.087)	<0.001	1.066 (1.047–1.085)	<0.001
SBT <100	2.171 (1.401–3.364)	<0.001	1.793 (1.018–3.158)	0.043	2.241 (1.376–3.650)	0.001
Heart rate >100	2.229 (1.407–3.532)	<0.001	2.308 (1.314–4.054)	0.004	2.091 (1.268–3.448)	0.004
Killip class 2–4	3.229 (1.872–5.572)	<0.001				
Patient delay	1.000 (0.998–1.002)	0.783				
Pre-hospital delay	1.001 (0.997–1.004)	0.402				
Door-to-balloon	1.005 (1.002–1.009)	0.003	1.004 (1.001–1.008)	0.017		
System delay (per min)	1.004 (1.002–1.006)	<0.001			1.003 (1.001–1.005)	0.005
Treatment delay	1.000 (0.998–1.002)	0.898				

AV: atrioventricular; CI: confidence interval; SBT: MI: myocardial infarction; systolic blood pressure; HR: heart rate.

Figure 4. Number of patients (%) that meet European Society of Cardiology (ESC) guidelines criteria for reperfusion with primary percutaneous coronary intervention (PPCI) within 120 minutes (blue); Number of patients (%) that stay below the time limit for PCI-related delay, above which pre-hospital fibrinolysis (PHF) has a theoretical advantage over PPCI (red); Number of patients (%) that stay below the time limit for PCI-related delay, above which in-hospital fibrinolysis (IHF) has a theoretical advantage over primary PCI (green). (A) overall population; (B) only directly referred patients.

administering fibrinolysis), the maximum acceptable time from FMC to PPCI would be 150 min: 120+30 min (30 min estimated door-to-needle time in case of in-hospital fibrinolysis or typical time consumption from EMS arrival to pre-hospital fibrinolysis initiation).²⁰ When in-hospital fibrinolysis is considered the alternative, acceptable PPCI-related delay increases for every minute of transport

to the local hospital. Scene time (18 min (10–24)) added to time from scene departure to local hospital (21 min (15–34)) yields an acceptable PCI-related delay of 150+18+21=189 min. Provided they were referred directly, roughly all patients transferred up to 185 km (zones 1–3) obtained timely reperfusion within this in-hospital fibrinolysis time limit. Contrary hereto, only

62.3% of directly referred patients from zone 3 (>100 km) (Figure 3) were treated with PPCI within 150 min (pre-hospital fibrinolysis limit) and only 16.3% and 32.7% of patients referred non-directly in zones 2 and 3 were treated with PPCI within 150 min and 189 min respectively. This possibly implies a role for pre-hospital fibrinolysis in patients transferred >100 km and for patients <75 years with anterior infarctions, as well as a role for in-hospital fibrinolysis in patients indirectly transferred. The reasons for indirect referral are shown in Figure 4, of notice only 10% of the overall 234 patients in zones 2 and 3 were non-directly transferred in spite of ST-segment elevation in the pre-hospital ECG, an obvious requirement for initiating pre-hospital fibrinolysis.

Alternative reperfusion regiments

Meta-analyses of randomized trials,^{21,22} registry studies²³ and sub-analyses²⁴ have all found that PPCI is superior to fibrinolysis at PCI-related delays up to 120 min, but the PPCI mortality advantage disappears as PCI-related delay increases.²⁵ Pre-hospital fibrinolysis with trained EMS paramedics reduces delay and mortality in comparison to in-hospital fibrinolysis,^{20,26} and compares well with PPCI when given within two hours, regarding one-year mortality rates.²³ In a pooled analysis of the only two randomized studies comparing pre-hospital fibrinolysis with PPCI, one-year mortality in patients treated with pre-hospital fibrinolysis was significantly reduced when treated within two hours of symptom onset.^{27,28}

The ‘pharmacoinvasive’ strategy combining early fibrinolysis (<3 hours after symptom onset) with early PCI (within 24 hours of fibrinolysis) yields survival rates comparable to PPCI²⁹ and is superior to a rescue PCI strategy,³⁰ yet a facilitated PPCI strategy with very early PPCI (1–3 hours) after fibrinolysis was associated with more major adverse events.³¹ Patients with long and non-direct transferrals (>97 km) (comparable to zone 3) treated with the pharmaco-invasive approach obtain a similar outcome to patients admitted directly to PPCI from shorter distances,³² and a pharmaco-invasive approach might even be preferred in high-risk STEMI patients who present early to a non-PCI center.³³ Alternatives strategies could be pre-hospital glycoprotein IIb/IIIa inhibitors,^{34,35} or bivalirudin,³⁶ and results from ongoing randomized trials are awaited.

Limitations

Patients are not consecutive as they were selected by having data entries in both pre- and in-hospital databases, with the inherent risk of selection bias. However baseline variables were well-balanced. We confirmed that system delay

independently predicts long mortality,⁴ and ground transfer of STEMI patients is safe,⁸ (Table 3) yet long term mortality between zones did not differ. This is probably due to a higher mortality in the first 24 hours (Table 3) in zone 1. We interpret these findings as inherent to our inclusion criteria of having PPCI performed, as only patients who survived until PPCI were able to enter the database with a PPCI procedure code. Longer transfer distances likely entail a natural selection of survivors from zones 2 and 3 for PPCI. This is supported by the higher occurrence of peri-procedural cardiogenic shock in zone 1 (Table 1). Disregarding mortality during the first 24 hours yields mortality rates that are more alike for all three zones. Lower blood pressure values during transfer in zone 1 could also be explained by more frequent use of intravenous β -blockers in zone 1 compared to zones 2 and 3 (9.8% vs 4.8%, $P=0.042$). The discrepancy in administration of bivalirudin, heparin and GP IIb/IIIa inhibitors (Table 1) is due to a feasibility study regarding pre-hospital administration of bivalirudin vs. heparin performed in zone 1 during this study’s inclusion period.³⁶

Only 7% of patients in this selected population were self-presenters. It is important to emphasize that this study concentrates on EMS-activated patients and likely underestimates the true dimension of self transport to a PCI or non-PCI Center.¹⁸ Finally overall sample size may be too small to demonstrate consistent mortality differences between zones and complete mortality associations with baseline or procedural variables.

Conclusion

Pre-hospital triage is feasible in 73% of STEMI patients. In spite of implemented telemedicine, reperfusion with PPCI was delayed beyond ESC guideline recommendations for patients living >100 km away and for patients being non-directly referred. System delay predicts all-cause mortality in STEMI patients and therefore pre-hospital triage should ensure the necessary expertise with EMS to allow direct transfer in as many STEMI patients as possible, as admission via a local hospital delays optimal care. Geographical zone stratification, enables identification of patients with long PCI-related delays. Pharmaco-invasive regiments, research in early ischemia detection, further EMS personnel education, and airborne transfer are possible options.

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Conflict of interest

None declared

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