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CLINICAL RESEARCH
Epidemiology and prevention

Reperfusion therapies and in-hospital outcomes for ST-elevation myocardial infarction in Europe: the ACVC-EAPCI EORP STEMI Registry of the European Society of Cardiology

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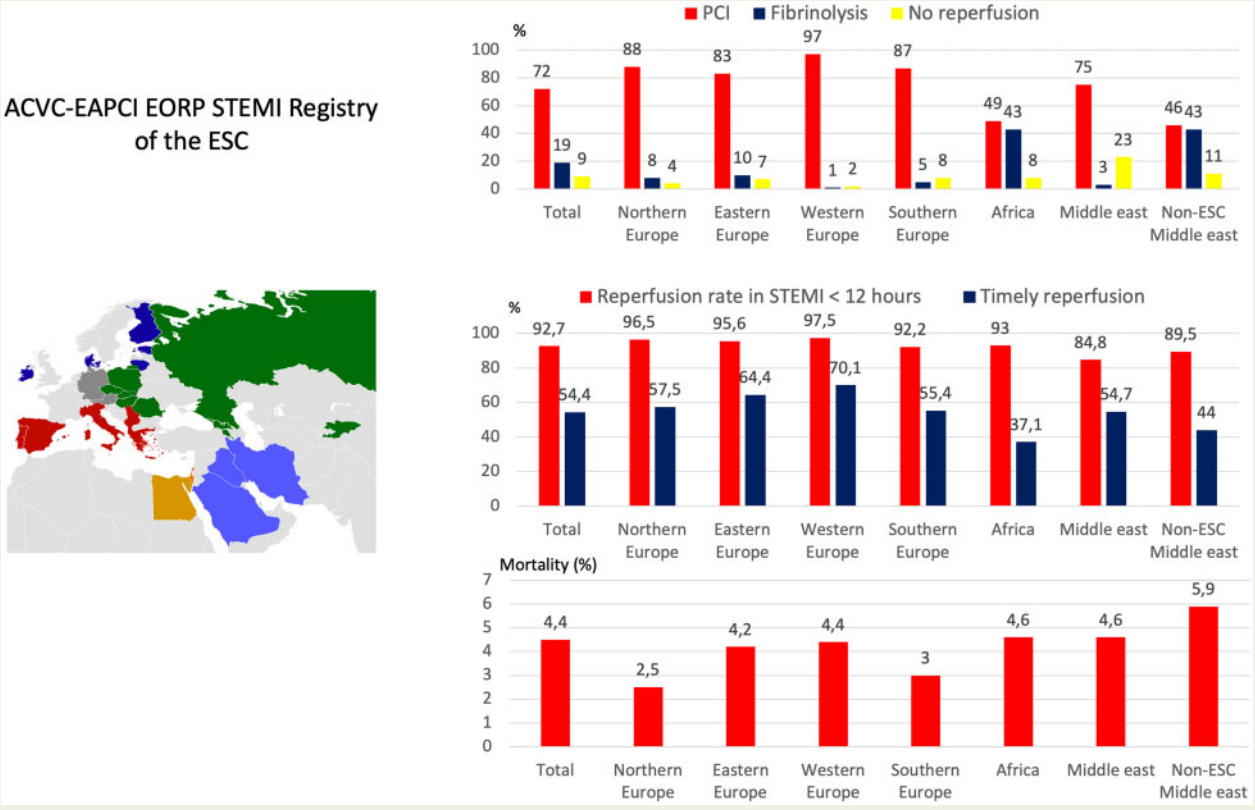
Aims The aim of this study was to determine the contemporary use of reperfusion therapy in the European Society of Cardiology (ESC) member and affiliated countries and adherence to ESC clinical practice guidelines in patients with ST-elevation myocardial infarction (STEMI).

Methods and results Prospective cohort (EURObservational Research Programme STEMI Registry) of hospitalized STEMI patients with symptom onset <24 h in 196 centres across 29 countries. A total of 11 462 patients were enrolled, for whom primary percutaneous coronary intervention (PCI) (total cohort frequency: 72.2%, country frequency range 0–100%), fibrinolysis (18.8%; 0–100%), and no reperfusion therapy (9.0%; 0–75%) were performed. Corresponding in-hospital mortality rates from any cause were 3.1%, 4.4%, and 14.1% and overall mortality was 4.4% (country range 2.5–5.9%). Achievement of quality indicators for reperfusion was reported for 92.7% (region range 84.8–97.5%) for the performance of reperfusion therapy of all patients with STEMI <12 h and 54.4% (region range 37.1–70.1%) for timely reperfusion.

Conclusions The use of reperfusion therapy for STEMI in the ESC member and affiliated countries was high. Primary PCI was the most frequently used treatment and associated total in-hospital mortality was below 5%. However, there was geographic variation in the use of primary PCI, which was associated with differences in in-hospital mortality.

Graphical Abstract



Current use of reperfusion therapies, achievement of quality indicators for reperfusion therapies and in-hospital mortality in Europe, North Africa and the Middle East. In Europe, about 85% of patients with ST-elevation myocardial infarction are treated with primary percutaneous coronary intervention, while total in-hospital mortality is around 4%. ESC, European Society of Cardiology.

Keywords ST-elevation myocardial infarction • Primary percutaneous coronary intervention • Observational studies • Reperfusion therapy

Introduction

The incidence of ST-elevation myocardial infarction (STEMI) in European countries ranges between 40 and 140/100 000/year, which equates to over 500 000 patients with STEMI being admitted each year.[1,2] Despite improvements in management, STEMI remains one of the leading causes of death in Europe and worldwide.[3–5] STEMI is defined by chest pain or equivalent symptoms and ST-segment elevation or left bundle branch block on the diagnostic electrocardiogram (ECG) and subsequent confirmation of diagnosis by elevation of cardiac troponin.[1,6] The European Society of Cardiology (ESC) has issued practice guidelines for patients with STEMI, the two latest versions published in 2012 and 2017.[1,6] It has been shown that adherence to these guidelines improves outcomes.[1,6] The cornerstone of treatment of STEMI is acute reperfusion therapy preferably with primary percutaneous coronary intervention (PCI). Previous surveys on acute coronary syndromes (ACS) within the EuroHeart Survey programme collecting data of ACS presentation, treatment and outcome in Europe in 2000, 2004, and 2008 and the Snapshot Registry in 2009 showed gaps between guideline recommendations and their implementation into clinical practice.[7–10] In addition, wide variations in the treatment of STEMI between countries have been noticed, especially in the use of primary PCI. The 'Stent for life' initiative of the ESC has been created to increase the rate of patients treated with primary PCI within Europe, the Mediterranean basin and other regions worldwide.[11–13] Therefore, this registry aimed to evaluate the evolution of treatment of STEMI in ESC member countries, adherence to guidelines and outcomes.

Methods

The design and methods of the registry have been published.[14,15] This study describes the demographic, clinical, and biological characteristics and outcomes of patients with STEMI admitted to cardiology centres in ESC member and affiliated countries.

Study organization

This registry is a joint initiative of the Association for Acute CardioVascular Care (ACVC) and the European Association of Percutaneous Cardiovascular Interventions (EAPCI) under the umbrella of the ESC EURObservational Research Programme (EORP). In each country, centres with and without PCI facilities were invited to participate. Each centre was asked to enrol at least 30 and up to 60 consecutive patients presenting with STEMI in the community within 24 h after symptom onset.

The study complies with the Declaration of Helsinki, the locally appointed ethics committees approved the research protocol, and informed consent was obtained from all subjects (or their legally authorized representatives).

Patients

Patients aged >18 years with an initial diagnosis of STEMI according to the 2012 ESC STEMI guidelines admitted within 24 h after symptom onset were identified on admission to the hospital, in the emergency room, or directly in the catherization laboratory and given a unique study number.

Data

Baseline data included demographics, patient history, and risk factors. Reperfusion therapies, time intervals, and the reasons why reperfusion was not utilized were also collected. Angiographic data and details of the revascularization procedures were collected. Medications given in the pre-hospital phase, during hospitalization, and at discharge were documented. Follow-up for clinical events was performed until hospital discharge.

Regions

To compare characteristics, treatments, and outcomes between different regions, the entire cohort was divided into seven regions according to the definition of the World Health Organization: Northern Europe (Denmark, Estonia, Finland, Ireland, Lithuania), Eastern Europe (Armenia, Czech Republic, Georgia, Hungary, Kyrgyzstan, Poland, Romania, Russia, Slovakia) Western Europe (Austria, Germany), Southern Europe (Albania, Greece. Italy, Kosovo, Malta, Montenegro, Portugal, Serbia, Spain), Africa (Egypt), Middle East (Israel), and non-ESC-Middle East (Iran, Iraq, Saudi Arabia).[15]

Definitions

Cardiogenic shock was defined according to the ESC STEMI guidelines.[1] Bleeding complications were classified according to the Bleeding Academic Research Consortium (BARC) definition.[16]

Quality indicators for reperfusion therapy

To assess the quality of care regarding reperfusion therapy, the following parameters were evaluated:[1,17] proportion of patients with STEMI <12 h who received reperfusion therapy; proportion of patients with timely reperfusion (fibrinolysis within 30 min after first medical contact and for patients with primary PCI admitted to centres with catherization laboratories <60 min from door to PCI, for transfer patients: qualifying ECG to PCI <120 min).

Statistics

Descriptive statistics are used to summarize frequency tabulations (*n*, %) and distributions (mean, standard deviation). All the results are summarized overall and by type of reperfusion therapy. For categorical data, frequency tabulations are presented (without missing values if applicable).

Results

From 1 January 2015 to 31 March 2018, 11 462 patients in 196 centres of 29 countries were enrolled in the registry. The numbers of patients per country ranged from 5 to 1356.[15] The baseline demographics of the entire cohort and patients in the seven regions are given in *Table 1*. There were variations with respect to age (North Africa 55.4 years, Northern Europe 64.2 years), female sex (Non-ESC Middle East 17.9%, Eastern Europe 28.7%), diabetes (Northern Europe 15.9%, North Africa 40.8%), smoking (Northern Europe 36.8%, North Africa 59.1%), and hypertension (North Africa 37.2%, Eastern Europe 54.0%) between the seven regions. Anterior STEMI was present in 49.1% of the patients without significant differences among regions. The other relevant clinical findings on admission are summarized in *Table 2*. Less than 5% of patients presented with cardiogenic shock.

Table 1 **Baseline characteristics of the total cohort and the seven World Health Organization regions**

	Total	Northern Europe	Eastern Europe	Western Europe	Southern Europe	North Africa	Middle East	Non-ESC Middle East
N	11 462	242	3846	270	2613	1356	756	2379
Age (years), *N* = 11 334	61.0 ± 12.8	64.2 ± 12.3	62.8 ± 12.2	62.3 ± 11.9	63.3 ± 12.7	55.4 ± 11.3	60.4 ± 14.3	58.7 ± 13.0
Women, *N* = 11 462	2643	67	1102	59	595	250	144	426
	23.1%	27.7%	28.7%	21.9%	22.8%	18.4%	19.0%	17.9%
Prior myocardial infarction	1264/10 417	27/239	557/3765	29/252	252/2574	107/1346	NA	292/2241
	12.1%	11.3%	14.8%	11.5%	9.8%	7.9%		13.0%
Previous PCI	1152/11 374	30/239	360/3822	31/257	247/2603	96/1353	171/753	217/2347
	10.1%	12.6%	9.4%	12.1%	9.5%	7.1%	22.7%	9.2%
Previous CABG	193/11 405	11/242	55/3827	4/262	33/2609	11/1355	22/753	57/2357
	1.7%	4.5%	1.4%	1.5%	1.3%	0.8%	2.9%	2.4%
Previous stroke/TIA	599/11 375	10/240	260/3815	12/257	104/2606	54/1354	41/755	118/2348
	5.3%	4.2%	6.8%	4.7%	4.0%	4.0%	5.4%	5.0%
Peripheral artery disease	470/10 883	10/236	244/3508	14/254	127/2532	12/1342	28/755	35/2256
	4.3%	4.2%	7.0%	5.5%	5.0%	0.9%	3.7%	1.6%
History of atrial fibrillation	451/11 348	19/242	226/3811	17/259	113/2605	21/1355	35/754	20/2322
	4.0%	7.9%	5.9%	6.6%	4.3%	1.5%	4.6%	0.9%
Diabetes	2996/11 204	38/239	817/3802	49/263	579/2607	547/1341	235/751	731/2201
	26.7%	15.9%	21.5%	18.6%	22.2%	40.8%	31.3%	33.2%
Current smoker	5123/11 204	86/234	1582/3708	123/258	1090/2585	799/1353	350/756	1093/2310
	45.7%	36.8%	42.7%	47.7%	42.2%	59.1%	46.3%	47.3%
Hypercholesterolemia	3770/9792	113/218	1288/2931	100/253	1051/2486	141/1111	482/750	595/2043
	38.5%	51.8%	43.9%	39.5%	42.3%	12.7%	64.3%	29.1%
Treated hypertension	5348/11 167	114/239	2019/3737	127/260	1334/2599	503/1351	398/750	853/2231
	47.9%	47.7%	54.0%	48.8%	51.3%	37.2%	53.1%	38.2%
Cancer or other life limiting diseases	224/11 234	5/238	93/3719	5/253	59/2584	9/1348	41/745	12/2347
	2.0%	2.1%	2.5%	2.0%	2.3%	0.7%	5.5%	0.5%

CABG, coronary artery bypass graft; ESC, European Society of Cardiology; PCI, percutaneous coronary intervention; TIA, transient ischaemic attack.

Table 2 **Clinical findings on admission in the total population and the seven World Health Organization regions**

	Total *N* = 11 462	Northern Europe *N* = 242	Eastern Europe N = 3846	Western Europe *N* = 270	Southern Europe *N* = 2613	North Africa *N* = 1356	Middle East *N* = 756	Non-ESC Middle East *N* = 2379
Anterior STEMI	5260/10 706	113/242	1772/3846	119/270	1201/2613	774/1356	NA	1281/2379
	49.1%	46.7%	46.1%	44.1%	46.0%	57.1%		53.8%
Other STEMI	5387/10 706	128/242	2048/3846	151/270	1399/2613	577/1356	NA	1084/2379
	50.3%	52.9%	53.3%	55.9%	53.5%	42.6%		45.6%
LBBB	56/10 706	1/242	24/3846	0/270	12/2613	5/1356	NA	14/2379
	0.5%	0.4%	0.6%	0.0%	0.5%	0.4%		0.6%
Atrial fibrillation on qualifying ECG Killip class	571/11 457	21/242	276/3846	19/270	132/2613	47/1356	22/756	54/2374
	5.0%	8.7%	7.2%	7.0%	5.1%	3.5%	2.9%	2.3%
I	9158/11 419	177/242	2874/3846	219/270	2086/2602	1137/1356	652/724	2013/2379
	80.2%	73.1%	74.7%	81.1%	80.2%	83.8%	90.1%	84.6%
II	1388/11 419	40/242	639/3846	31/270	309/2602	134/1356	40/724	195/2379
	12.2%	16.5%	16.6%	11.5%	11.9%	9.9%	5.5%	8.2%
III	425/11 419	12/242	162/3846	6/270	94/2602	46/1356	15/724	90/2379
	3.7%	5.0%	4.2%	2.2%	3.6%	3.4%	2.1%	3.8%
IV	448/11 419	13/242	171/3846	14/270	113/2602	39/1356	17/724	81/2379
	3.9%	5.4%	4.4%	5.2%	4.3%	2.9%	2.3%	3.4%
Heart rate (b.p.m.), *N* = 11 429	79.8 ± 20.0	75.5 ± 19.1	79.0 ± 20.0	77.1 ± 20.8	77.8 ± 19.1	84.8 ± 19.4	80.4 ± 18.8	81.1 ± 21.2
Mean systolic blood pressure (mmHg), *N* = 11 431	133.2 ± 28.0	133.7 ± 29.3	135.4 ± 27.8	138.7 ± 29.5	133.7 ± 28.2	125.5 ± 25.8	138.1 ± 28.7	131.2 ± 28.0
Out-of-hospital cardiac arrest	482/10 963	13/242	255/3846	22/269	84/2613	34/1356	34/258	40/2379
	4.4%	5.4%	6.6%	8.2%	3.2%	2.5%	13.2%	1.7%

ECG, electrocardiogram; LBBB, left bundle branch block; STEMI, ST-elevation myocardial infarction.

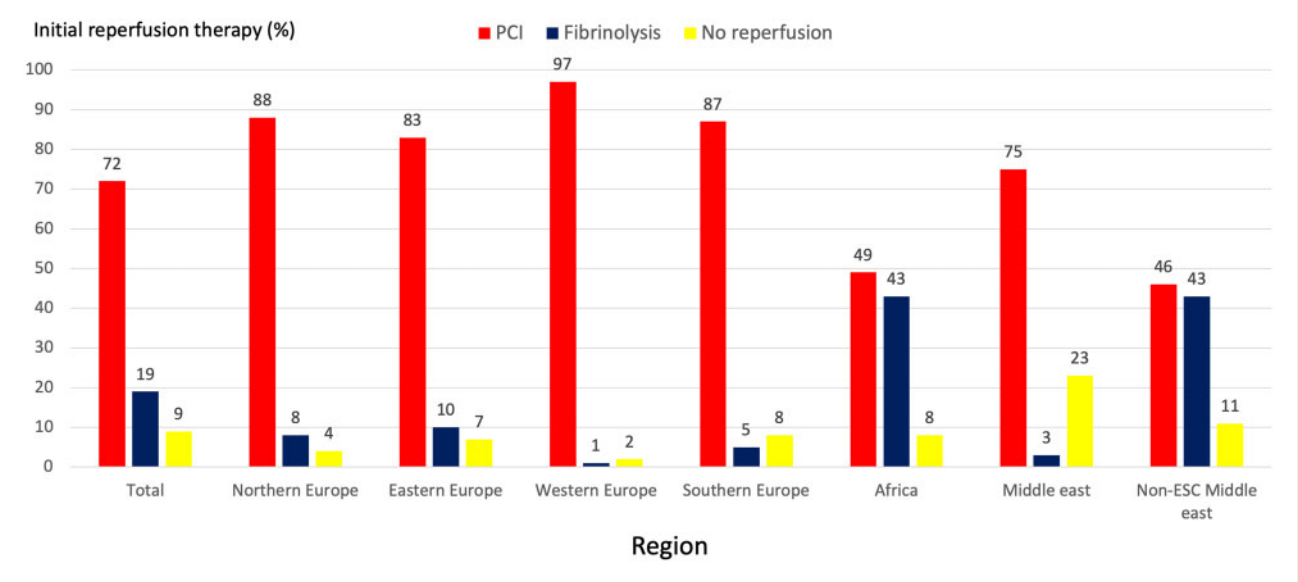


Figure 1 Rate of reperfusion therapies performed in the total cohort and the seven World Health Organization regions. ESC, European Society of Cardiology; PCI, percutaneous coronary intervention.

Reperfusion therapy

The intended treatment was primary PCI in the admission centre in 7338 (68.4%) cases of STEMI, transfer out for primary PCI at another hospital in 353 (3.1%), fibrinolysis in 1999 (17.4%), no acute reperfusion therapy in 630 (5.5%), and not determined in 643 (5.6%). Treatment actually received was primary PCI in 72.2% (country range 0–100%), fibrinolysis in 18.8% (country range 0–100%), and no acute reperfusion therapy in 9.0% (country range 0–75%). While primary PCI was performed in over 80% of patients in the ESC member countries in Europe and in 75% in the ESC Middle East, the rate was around 50% in North Africa and the non-ECS Middle East countries (*Figure 1*). In the European ESC members countries, the rates of primary PCI, fibrinolysis and no reperfusion therapy were 85.4% (5955/6971), 7.6% (530/6971), and 7.0% (486/6971). The reasons for not performing acute reperfusion therapy in the 1027 patients of the total cohort were as follows: clinically inappropriate (19.4%), contraindication to anticoagulation/antiplatelet therapy (5.2%), late presentation (38.9%), spontaneous reperfusion (15.6%), wrong diagnosis (3.7%), patient refusal (5.1%), and others (12.2%).

The mean time interval between symptom onset and first medical contact was 221.6 min and the mean time between first medical contact and primary PCI was 195.2 min (*Table 3*). Primary PCI was performed in 61.8% within 120 min after first medical contact. The majority of patients (55.8%) were admitted by an ambulance or emergency medical service, the remaining admissions were self-presenters, while 66.8% of patients presented directly to a PCI hospital.

Medical therapy

The acute antithrombotic therapies used according to reperfusion treatment are summarized in *Table 4*. The use of aspirin was over 97% and the most widely used P2Y12 inhibitor was clopidogrel. Intravenous antiplatelet agents were given in about 19% of patients, predominantly glycoprotein IIb/IIIa inhibitors. With respect to anticoagulation, unfractionated heparin was most frequently used followed by low molecular weight heparins, while bivalirudin and fondaparinux were administered only rarely. Beta-blockers were given in 86.4% of patients, angiotensin-converting enzyme inhibitors in 77.7% and angiotensin receptor blockers in 7.6%, sacubitril/valsartan in 0.1%, mineralocorticoid receptor antagonists in 16.7%, and ivabradine in 3.7%. With respect to low-density lipoprotein-lowering therapy a statin was given in 96.4% of patients, ezetimibe in 0.8% and fibrates in 0.3%. Proton pump inhibitors were prescribed to 70.3% of patients.

In-hospital procedures and outcomes

Median length of stay was 5 days and ranged between 3 days (North Africa) and 6 days (Eastern, Western, and Southern Europe). Emergency coronary artery bypass graft surgery was performed in only 88 (0.8%) patients. Additional revascularization procedures after day one were done in 11.3% of patients and are listed in *Table 5*. In addition, 10.0% of patients were scheduled for a staged PCI procedure after discharge.

In patients treated with primary PCI, radial access was used in 4815, femoral access in 3923 and both in 97 patients. Corresponding BARC 2-5 bleeding complications were 2.0%, 3.6%, and 9.2%, and in-hospital mortality rates 1.9%, 4.8%, and 7.2%, respectively.

A total of 212 (9.8%) of 2046 patients treated with fibrinolysis received PCI within 24 h after admission. In-hospital mortality was 1.0% vs. 4.8% compared to patients without early PCI.

Overall in-hospital mortality was 4.4%. It varied from 2.5% to 5.9% across the seven regions (Supplementary material online, *Figure S1*) and was 3.8% in the European and Middle East ESC member countries ($n = 7727$). In-hospital mortality in patients with the different reperfusion strategies is shown in *Figure 2*. Mortality in patients with

Table 3 **Time intervals between symptom onset, first medical contact and percutaneous coronary intervention in the total population and the seven World Health Organization regions**

	Total	Northern Europe	Eastern Europe	Western Europe	Southern Europe	North Africa	Middle East	Non-ESC Middle East
Symptom-onset to FMC (min), *N* = 11 214	221.6 ± 460.6	249.9 ± 812.5	257.3 ± 486.7	233.0 ± 408.7	227.6 ± 531.3	201.6 ± 255.6	251.1 ± 765.9	158.0 ± 218.0
FMC to PCI (min), *N* = 8165	195.2 ± 1105.6	227.5 ± 389.9	197.6 ± 565.2	193.9 ± 906.9	215.6 ± 1948.7	147.1 ± 241.6	131.9 ± 179.9	197.2 ± 237.4
FMC to PCI <30 min	291/8165	2/214	78/3197	4/259	100/2264	38/663	20/485	49/1083
	3.6%	0.9%	2.4%	1.5%	4.4%	5.7%	4.1%	4.5%
FMC to PCI <60 min	1690/8165	20/214	598/3187	60/259	456/2264	286/663	106/485	164/1083
	20.7%	9.3%	18.7%	23.2%	20.1%	43.1%	21.9%	15.1%
FMC to PCI <120 min	5044/8165	119/214	2028/3197	174/259	1404/2264	466/663	348/485	505/1083
	61.8%	55.6%	63.4%	67.2%	62.0%	70.3%	71.8%	46.6%

FMC, first medical contact; PCI, percutaneous coronary intervention.

Table 4 Antithrombotic therapy according to reperfusion therapy during the first 24 h in the entire cohort and according to initial reperfusion therapy

	Total *N* = 11 462	Primary PCI *N* = 8275	Fibrinolysis *N* = 2160	No reperfusion therapy *N* = 1027
Aspirin	11 151/11 449	8053/8263	2141/2160	957/1026
	97.4%	97.5%	99.1%	93.3%
Clopidogrel	7486/11 450	4674/8263	2054/2160	758/1027
	65.4%	56.6%	95.1%	73.8%
Prasugrel	1246/11 450	1171/8264	25/2160	50/1026
	10.9%	14.2%	1.2%	4.9%
Ticagrelor	2705/11 451	2482/8264	94/2160	129/1027
	23.6%	30.0%	4.4%	12.6%
Dual antiplatelet therapy	10 995/11 448	7967/8262	2134/2160	894/1026
	96.0%	96.4%	98.8%	87.1%
GP IIb/IIIa inhibitors	2078/10 696	1864/7697	172/2145	42/854
	19.4%	24.2%	8.0%	4.9%
Cangrelor	8/10 696	7/7697	1/2145	0/854
	0.1%	0.1%	0.05%	0%
Unfractionated heparin	7300/11 442	5771/8255	1010/2160	519/1027
	63.8%	69.9%	46.8%	50.5%
Low molecular weight heparin	4253/11 443	2634/8256	1189/2160	430/1027
	37.2%	31.9%	55.0%	41.9%
Bivalirudin	134/11 345	128/8187	4/2160	2/998
	1.2%	1.6%	0.2%	0.2%
Fondaparinux	222/11 340	163/8181	33/2160	26/999
	2.0%	2.0%	1.5%	2.6%

GP, glycoprotein; PCI, percutaneous coronary intervention.

cardiogenic shock was 10-fold higher than in patients without shock (35.5% vs. 3.1%) (Supplementary material online, *Figure S1*). Mechanical complications were reported in 0.7% of patients. Definite or probable stent thrombosis occurred in 1.2%, and a re-infarction in 1.0%. Cerebrovascular accidents were rare and mostly ischaemic. A BARC bleeding complication was reported in 5.8% of patients and a transfusion was given in 2.1% (*Table 5*). The in-hospital mortality of the 372 (3.2%) patients with BARC 2–5 bleeding complications was 15.3% vs. 4.0% in the 11 083 patients with no or BARC-1 bleeding complications. A total of 2584 (24.1%) patients experienced heart failure during the index hospitalization. The mean left ventricular ejection fraction was lower in the heart failure cohort compared to patients without heart failure (39.9 ± 11.6% vs. 48.1 ± 10.3%), and the corresponding in-hospital mortality was 13.5% vs. 1.4%. Patients with atrial fibrillation on the qualifying ECG ($n = 571$, 5%) received primary PCI in 73.7% vs. 72.1%, fibrinolysis in 13.7% vs. 19.1% and no early reperfusion therapy in 12.6% vs. 8.8%. During hospital stay, they had more often stroke (2.8% vs. 0.9%) and a higher in-hospital mortality (13.0% vs. 3.9%).

Achievement of quality indicators for reperfusion therapy

The proportion of patients reperfused among eligible patients with STEMI <12 h ranged from 84.8% to 97.5% in the seven regions (*Figure 3*), while timely reperfusion was achieved in 54.4% (region range 37.1–70.1%).

Discussion

The major finding of the current EORP STEMI registry is that primary PCI was the preferred reperfusion therapy in patients with STEMI in Europe and the participating Middle East countries. In the first EuroHeart Survey ACS registry in 2001, primary PCI was used in about 20% of patients, while in the current analysis the PCI rate in European ESC member countries has risen to about 80% (*Figure 3*). This increase may in part be due to the success of the 'Stent for Life' initiative of the ESC[11] and also the very strong guideline recommendation that primary PCI should be the preferred approach for the treatment of STEMI.[1,6] In contrast, the use of fibrinolytic therapy decreased over time from 35% in 2001 and to about 20% in the whole cohort and less than 10% in the European countries now (*Figure 4*). About 10% of patients still did not receive early reperfusion therapy, with late presentation as the most often reported reason. The rate of patients without reperfusion therapy in the ESC member countries has declined the last 20 years, starting with over 40% in the first EuroHeart Survey on ACS and <10% in the current study. As in previous reports, patients receiving no reperfusion therapy had a high in-hospital mortality, which was nearly 15% in this registry (*Graphical abstract*). Public campaigns are therefore still warranted to

help minimize patient-related pre-hospital delays, to reduce the rate of patient presenting too late to benefit from early reperfusion therapy. Nevertheless, there will always remain some patients who are not treated with reperfusion therapy for appropriate clinical reasons such as frailty or severe concomitant diseases.

The increase in the use of primary PCI has been accompanied by a decrease in mortality, from 7.0% in the year 2000 to 4.0% in the years 2016–2018, supporting the widespread use of this therapy in STEMI, as also described by others.[19]

There remain variations in the use of primary PCI between regions ranging from 46% in the non-ESC Middle East countries to 75% and 98% in the European ESC member countries. These variations were associated with differences in total in-hospital mortality, from 5.9% in the Middle East non-ESC countries to 2.5% in Northern Europe. Therefore, all efforts should be made to increase the use of primary PCI in all regions to improve outcome in STEMI. As recommended in the ESC guidelines,[1,6] this can be achieved by creating STEMI networks with clearly defined patient pathways.

Table 5 In-hospital additional procedures and complications

PCI after fibrinolysis	892/2160 (41.3%)
PCI after initial no reperfusion	285/1027 (27.8%)
Staged PCI after primary PCI	863/7644 (11.3%)
Total CABG	327/11 458 (2.9%)
Stent thrombosis	
Definite	106/11 416 (0.9%)
Probable	34/11 416 (0.3%)
Reinfarction	120/11 460 (1.0%)
Stroke	115/11 460 (1.0%)
Heart failure	2584/10 702 (24.1%)
Total BARC bleeding complications	667/11 455 (5.8%)
BARC 2–5 bleeding complications	372/11 455 (3.2%)

BARC, Bleeding Academic Research Consortium; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention.

The ESC guidelines recommend a time of <120 min between first medical contact and primary PCI. This goal was achieved in only about 60% of cases, while only 20% were treated in less than 60 min. Accordingly, logistics of care should be continuously improved to further reduce total ischaemic time.

Quality indicators for reperfusion therapy were met for over 90% of patients with STEMI <12 h, while timely reperfusion was achieved in only about half of the patients underscoring the need for the improvement of logistics.

Aspirin is still the cornerstone of antiplatelet therapy in patients with STEMI regardless of the initial reperfusion therapy and was used in over 95% of the patients. Despite the recommendations in favour of the newer P2Y12 inhibitors prasugrel and ticagrelor in the ESC guidelines, clopidogrel was the most often used second antiplatelet agent. The reasons might include limitations in the availability of prasugrel and ticagrelor and cost. With respect to anticoagulation, unfractionated heparin and low molecular weight heparins were the preferred drugs, while bivalirudin and fondaparinux were used only rarely.

Current guidelines recommend dual antiplatelet therapy regardless of the initial reperfusion therapy and 96% of the patients actually received dual antiplatelet therapy at discharge. Statins were given in almost 96% of patients, which documents the widespread acceptance of the low-density lipoprotein lowering as very important therapy in patients with STEMI.

In patients without cardiogenic shock, mortality was as low as 3.9%, while the occurrence of cardiogenic shock was still associated

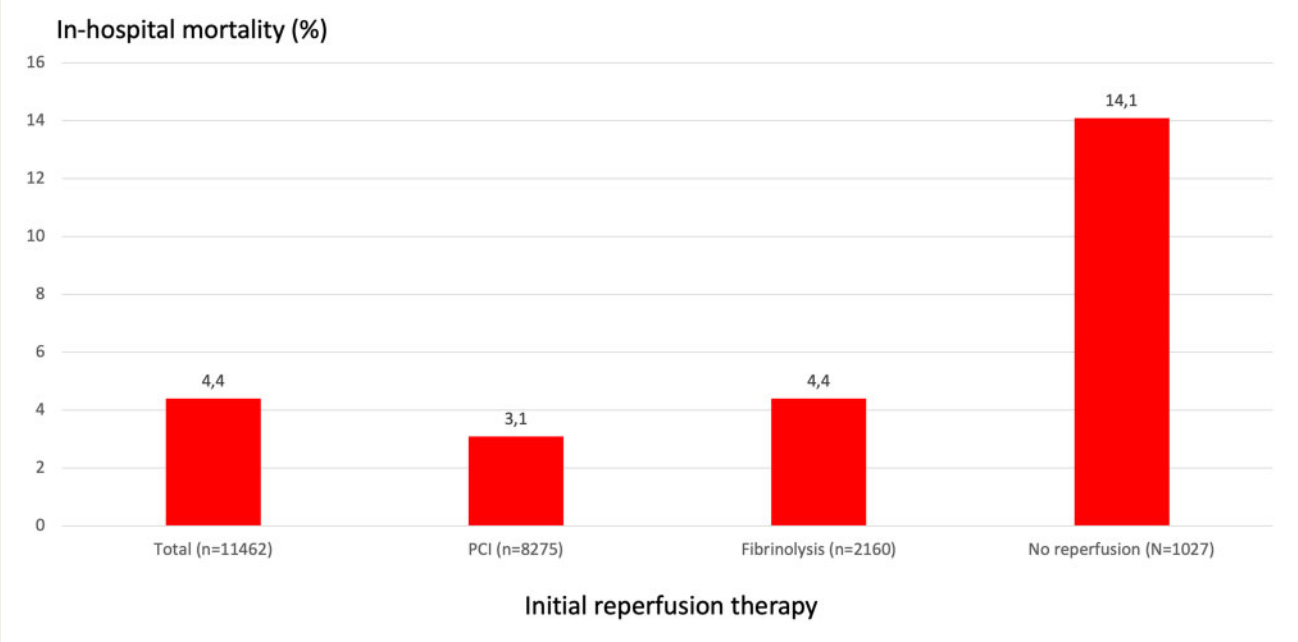


Figure 2 In-hospital mortality in the total cohort and subgroups of patients treated with percutaneous coronary intervention, fibrinolysis, and no initial reperfusion therapy.

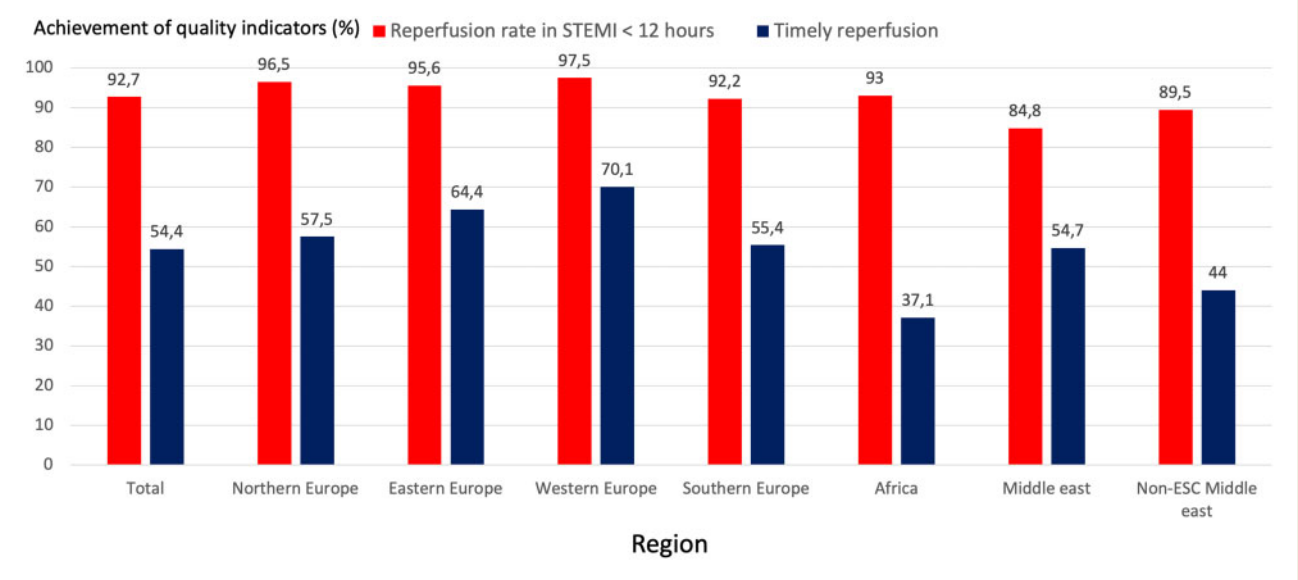


Figure 3 Achievement of quality indicators for reperfusion therapies. Rate of patients with reperfusion therapy (percutaneous coronary intervention or fibrinolysis) among all patients with ST-elevation myocardial infarction <12 h and rate of patients with timely reperfusion (fibrinolysis within 30 min after first medical contact and for patients with primary percutaneous coronary intervention admitted to centres with catheterization laboratory <60 min from door to arterial access, for transfer patients: qualifying electrocardiogram to percutaneous coronary intervention <120 min).

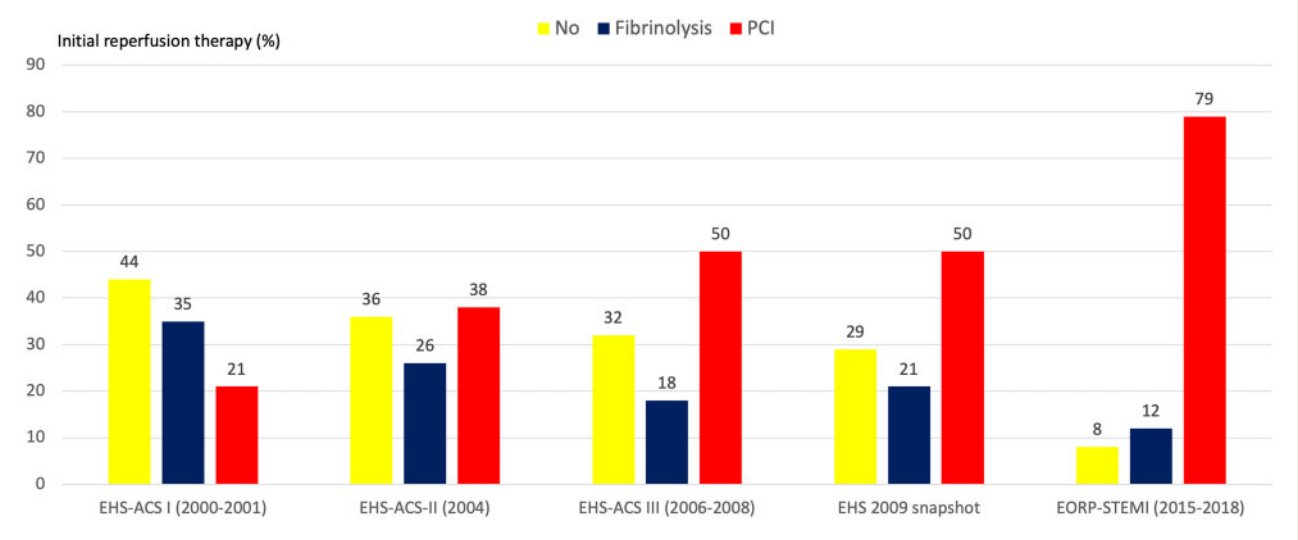


Figure 4 Temporal trends in the use of reperfusion therapies in patients with ST-elevation myocardial infarction in Europe over the last 20 years in the EuroHeart Surveys I to III, the EuroHeart Surveys Snapshot Survey and the EORP ST-elevation myocardial infarction registry.

with a high mortality of 35%. This was somewhat lower than the mortality reported in randomized trials including patients with cardiogenic shock, which approximates 40%.[18] Nevertheless, it suggests that major improvements in total mortality rates can only be achieved if mortality due to cardiogenic shock will be reduced.[19]

Limitations

Despite the large number of patients included, the representativeness of the patient population for Europe was somewhat limited. The national sites were selected by the National Societies of Cardiology with the aim to provide a representative sample within the given

country. However, since participation was voluntary, a selection bias with participation of 'better' centres cannot be excluded and therefore the reality might be less favourable. The larger European countries such as France, Germany and the United Kingdom did not participate or enrol a sufficient number of patients.

Actions to be taken

The findings of this registry imply further steps to be seriously taken into consideration to improve STEMI quality of care: continuous public campaigns should be performed to raise awareness and reduce the interval between symptom onset and first medical contact; improvement of logistics should be implemented to minimize delays so as to increase the number of patients treated with primary PCI within 120 min or preferably 60 min after first medical contact. A further increase in the use of primary PCI could be achieved by implementing patient pathways within STEMI networks and future research is needed to reduce mortality in patients with cardiogenic shock to substantially improve overall mortality.

Supplementary material

Supplementary material is available at *European Heart Journal* online.

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Data availability

Data request can be send to EORP at the European Heart House, Sophia Antipolis France.

Appendix A—ACS STEMI

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