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Reperfusion therapy for ST elevation acute myocardial infarction 2010/2011: current status in 37 ESC countries

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Aims Primary percutaneous coronary intervention (PPCI) is the preferred reperfusion therapy in ST-elevation myocardial infarction (STEMI). We conducted this study to evaluate the contemporary status on the use and type of reperfusion therapy in patients admitted with STEMI in the European Society of Cardiology (ESC) member countries.

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Methods and results A cross-sectional descriptive study based on aggregated country-level data on the use of reperfusion therapy in patients admitted with STEMI during 2010 or 2011. Thirty-seven ESC countries were able to provide data from existing national or regional registries. In countries where no such registries exist, data were based on best expert estimates. Data were collected on the use of STEMI reperfusion treatment and mortality, the numbers of cardiologists, and the availability of PPCI facilities in each country. Our survey provides a brief data summary of the degree of variation in reperfusion therapy across Europe. The number of PPCI procedures varied between countries, ranging from 23 to 884 per million inhabitants. Primary percutaneous coronary intervention and thrombolysis were the dominant reperfusion strategy in 33 and 4 countries, respectively. The mean population served by a single PPCI centre with a 24-h service 7 days a week ranged from 31 300 inhabitants per centre to 6 533 000 inhabitants per centre. Twenty-seven of the total 37 countries participated in a former survey from 2007, and major increases in PPCI utilization were observed in 13 of these countries.

Conclusion Large variations in reperfusion treatment are still present across Europe. Countries in Eastern and Southern Europe reported that a substantial number of STEMI patients are not receiving any reperfusion therapy. Implementation of the best reperfusion therapy as recommended in the guidelines should be encouraged.

Keywords Primary percutaneous coronary intervention • STEMI • Treatment variation • Europe

Introduction

Guidelines from the European Society of Cardiology (ESC) call for timely coronary artery reperfusion in patients with ST-elevation myocardial infarction (STEMI) and stress that, if available, primary percutaneous coronary intervention (PPCI) is the preferred strategy.[1] Despite its advantages, PPCI is not universally implemented and thrombolysis is still used in many patients. Furthermore, a large group of patients presenting with STEMI are not receiving any reperfusion therapy.[2–4] The reasons for these differences in the use of reperfusion therapy in the ESC countries are poorly understood. However, prior studies suggest that clinical factors, financial concerns as well as obstacles, and organizational difficulties are key factors.[5,6] To overcome these types of barriers, systems of care have been developed such as establishment of regional STEMI networks with very encouraging results.[7,8]

This descriptive study reports the current use of reperfusion treatment in 37 ESC countries. The study is a follow-up of the survey conducted in 2007 including more countries. A total of 27 countries participated in both surveys. The present survey includes the same study variables collected in the former survey, whereas the data sources vary.[4]

Methods

This was a cross-sectional descriptive study based on aggregated survey data from 36 ESC member countries and 1 affiliated ESC country in 2010/2011. The 55 National Societies within the ESC were kindly asked to provide country-level data. Positive replies were received from 37 ESC countries, including one affiliated ESC country. The collection of data was a substantial task, and consequently, one representative/contact person from each country is listed as a co-author of this report. The study consisted of self-administered questionnaires completed by the national contact persons providing information on the following items: the number of STEMI patients per 1 000 000 inhabitants treated with (i) PPCI, (ii) thrombolysis, and (iii) patients receiving no reperfusion therapy. We also collected data on mortality assessed as overall in-hospital mortality according to the type of reperfusion therapy. Furthermore, we gained data on information on existing national STEMI or PCI registries and on the organization of treatment management (number of PPCI centres per 1 000 000 inhabitants and number of cardiologists per 1 000 000 inhabitants). Twenty-seven of the 37 countries were also participating in the survey conducted in 2007/2008, and data on the utilization of PPCI were available for comparison. Numbers of patients treated with thrombolysis and the numbers of patients not receiving reperfusion therapy were in 2007/2008 given as percentage and can therefore not be compared.

Since most of the countries in Europe at present do not have national or regional registries on PPCI or STEMI, we allowed the national contact persons to report their best estimates. The following country data were based solemnly on contact person's estimates: Azerbaijan, Bosnia and Herzegovina, Georgia, and the Netherlands. Only nine countries (Austria, Belgium, Denmark, Germany, Iceland, Italy, Poland, Sweden, and UK) have national registries covering the entire STEMI population with mandatory registration and continued data validation (*Table 1*). After conduction of the survey in 2007/2008, a substantial number of countries have taken the initiative to establish more permanent data registries with national coverage. Examples are Romania and Bulgaria with fairly new established registries covering 70% of the STEMI population. The completeness of STEMI capturing during the time period in the various registries ranged from 14.5% coverage in Greece to 100% coverage in some countries, i.e. Denmark, Sweden, and the UK. In some countries, e.g. France, Egypt, Greece, Ireland, and Slovakia, data were based on surveys and snapshots. A full description of the data sources are given in *Table 1*. Since mortality data are highly dependent on sound registration, we choose to include only mortality data from countries where a national STEMI registry and a national PCI registry exist (*Table 3*).

Data analysis

We provided descriptive analysis of the type of reperfusion utilization in 2010/2011 for each country. For the 27 countries participating in both surveys, we moreover included comparative numbers on the utilization of PPCI. The use of reperfusion therapy is presented as numbers per 1 000 000 inhabitants. Numbers of available cardiologists are presented per 1 000 000 inhabitants and numbers of available PPCI hospitals per mean population. Correlation between the number of cardiologists per 1 000 000 inhabitants and the number of performed PPCI per million inhabitants was done using Spearmans' rank correlation test. Mortality data are presented as percentages.

Table 1 Description of country data sources

Country	Data from the year	Existing national PCI registry	Existing regional PCI registry	Existing national STEMI registry	Existing regional STEMI registry	Expert estimates only	Completeness of STEMI capturing per period/ percentage of STEMI population covered by the registry	Comments to data content
Austria[a]	2011	Austrian PCI registry	PCI registry Wilhelminen Hospital Vienna	No	Vienna, STEMI registry		90% (estimate)	
Azerbaijan	2011					x		
Belgium[a]	2011	Belgian PCI registry	No	Belgian STEMI registry	No		STEMI database 50% PCI database 100%	
Bosnia and Herzegovina	2011					x		
Bulgaria	2011	Started November 2011	No	Started November 2012	No		70%	Data from various sources: The National Health Insurance Fund, National Social Security Institute, National Center of Public Health and Analyses as well as from the National PCI centres
Croatia[a]	2011	No	Yes	Yes	Yes		>90%	Croatian Institute for Public Health and regional and in-hospital ACS/STEMI/PPCI registries
Cyprus	2009	No	No	No	No		NA	Data for STEMI were based on CYPACS Study/ Registry in 2009. Data for PPCI were based on unpublished data for the year 2011, presented at the Cyprus Society of Cardiology National Congress, year 2012
Czech Republic	2011	Yes	Yes	No	Yes		92%	Register + approximation based on current and older data
Denmark	2010	The Danish Heart Registry	The Western Denmark Heart Registry, PATS (The Eastern Denmark Heart Registry	The Danish National Patient Registry	The Danish National Patient Registry		100%	
Egypt	2011	Yes	Yes				36%, 31 million people	Based on the 1st Phase of Egyptian Stent For Life registry (9 months). Four areas only: Cairo, Alexandria, Delta, and Canal. Fourteen cath labs
Finland	2011	No	Yes	No	Yes—some		Near 100%	PCI data based on registry data, STEMI data based on expert estimates

Continued

Table 1 *Continued*

Country	Data from the year	Existing national PCI registry	Existing regional PCI registry	Existing national STEMI registry	Existing regional STEMI registry	Expert estimates only	Completeness of STEMI capturing per period/ percentage of STEMI population covered by the registry	Comments to data content
France[a]	2011	ONACI	RICO, Cardio ARIF, ORBI, Center registry, PACCA registry, Alpine registry	No	RICO, Cardio ARIF, ORBI, Center Registry, PACCA registry, Alpine registry		35%	Based on the FAST-MI survey data
Georgia	2011	No	No	No	No	x		Numbers are based on data from only five PCI centres. (insured patients only)
Germany	2011	No	Yes Berlin, Essen, Hildesheim/ Association of Clinical Cardiology Directors (ALKK) Ludwigshafen/ALKK	No	Yes			Activity numbers are based on BQS: AQUA-Institut, data collection is mandatory. Staff numbers are based on Bruckenberger, the German Heart Statistics 2011
Greece	2011	No	Yes	No	No		14.5 %	Data based on Stent for Life Registry, Hellenic PCI Registry
Hungary	2011	Yes	Yes	Partially	Yes		50% Snapshot survey (2011) 92%	
Iceland	2011	Yes	Yes	Yes	Yes		PCI 100% STEMI 95%	SWEDEHEART. Data on the use of thrombolysis are based on expert estimates
Ireland	2011	No	No	No	No		NA	(1) Heartbeat voluntary STEMI database of 20 participating hospitals (July 2011 to June 2012) covering 58% of the population (in conjunction with CHAIR regional registry and HIPE national hospital administrative system) (2) Medical Council (registering body) for the number of cardiologists
Israel	2010	Yes	Record PCI	1—ACSIS ACS	1 Recode PCI		Data are extrapolated (i.e. six times) from a 2-month national ACS surveillance	ISRAEL ACSIS 2010 National ACS Registry
Italy	2010	Yes	Yes	Yes	Yes		BLITZ 1 (2 weeks snapshot in >90% Italian CCUs; BLITZ-4 a weeks snapshot representative of approximately one-fifth of total CCUs)	Data are based on GISE database[a], data on thrombolysis, and no reperfusion are based on BLIZ-4

Latvia[a]	2011	No	Yes	Yes	No	90%	
Marcedonia[a]	2011	Yes	Yes	Yes	Yes	85%	Based on national registry
Netherlands	2011	Yes	Yes	No	No	Yes	Based on expert estimate and extrapolation of data from 18 interventional centres
Portugal	2011	2 different	No	2 different	No	NA	
Poland[a]	2011	Yes	Yes	Yes	Yes		PL-ACS registry, national PCI database, thrombolysis, and number of patients not receiving any reperfusion are based on expert opinion
Romania[a]	2011	Yes	No	Yes	No	70%	Based on RO-STEMI
San Marino	2011	No	No	Yes	No	100%	
Saudi Arabia	2011	Yes	No	Yes	Yes	Representative snapshot, particularly of the governmental tertiary care hospitals	(1) National PCI Registry (CARES) (2) National ACS Registry (SPACE) (3) Regional ACS Registries (Gulf RACE-1 and Gulf RACE-2) (4) National experts estimates
Serbia[a]	2011	No	Yes	Yes	No	National registry for ACS covers all hospitalized ACS patients in Serbia	Clinical Centre of Serbia PPCI registry, National registry for ACS, Annual cath-lab reports of all PCI centres
Slovakia	2011	No	No	Yes	Yes	80–90%	Based on a 2-month snapshot covering 90% of hospitals. The results are multiplied by six to get 1-year data.
Slovenia	2011	No	In each CL	No	In each CL	100%	
Spain	2010	Yes	Yes	Yes	Yes	28.73% based on Regional STEMI Networks Registry	Spanish Society of Cardiology, PCI Registry. Prevalence of STEMI vs. non-STEMI based on MASCARA registry. Thrombolysis was based on the Spanish Society of Cardiology, PCI Registry (6% ACS non-classifiable)
Sweden[a]	2011	Yes	No	Yes	No	100%	Swedeheart, HIA
Switzerland[a]	2011	No, a nationwide annual survey of PCI	No	AMIS plus		AMIS plus ca. 30%	Information based on voluntarily hospitals participation in AMIS Plus Registry
Turkey	2011	No	No	No	No		Data sent from 25 pilot cities of SFL initiative
UK[a]	2010 and 2011	Yes MINAP BCIS	Yes	Yes	Yes	100%	BCIS PPCI data for all UK 2011. MINAP data for 2010 England and Wales—thrombolysis
Ukraine	2011	Yes (covering just 75%)	No	No	No	NA	Information based on data from 'Ukrainian Register of Percutaneous Coronary Interventions', reporting the Ministry of Health. Personal communication with PCI centres

CCU, Critical Care Unit; CL, County Level; HIA, Healt Impact Assesment.
[a]Based on the same data sources as the survey published in 2010[4].

Table 2 Number of available cardiologists, hospitals capable of performing acute and non-acute percutaneous coronary intervention, and population per centre

Country	Country population 1 January 2011	Mean number of board-certified cardiologists per million population	Numbers of PCI hospitals	Numbers of PCI hospitals with 24/7 PPCI service	Mean population per PPCI centre (24/7 service)
Austria	8 404 252	35.7	36	14[a]	600 300
Azerbaijan	9 111 078	0.22	7	4	2 280 000
Belgium	10 951 665	73.0	36	36	304 000
Bosnia and Herzegovina	3 843 183	21.1	5	2	1 922 000
Bulgaria	7 504 868	86.6	33	33	227 500
Croatia	4 412 137	NA	12	9	490 300
Cyprus	804 435	165	4	0	NA
Czech Republic	10 513 209	71.3	22	22	478 000
Denmark	5 560 628	58.4	7	5	1,112,000
Egypt[a]	82 079 632	25.8	93	31	2,654,800[a]
Finland	5 375 276	24.7	23	3	1 792 000
France[b]	65 821 885	9.1	210	210[b]	313 000[a]
Georgia[b]	4 469 250	33.6	9	4	1 117 300[a]
Germany	81 780 000	36.0	521	NA	NA
Greece[b]	10 787 690	243.8	49	15	754 000
Hungary[b]	9 985 722	40.0	17	17	587 400
Iceland	318 452	78.5	1	1	318 500
Ireland	4 480 858	22.1	16	4	1 120 200
Italy[b]	60 626 442	NA	255	211	287 300
Israel	7 873 052	72.2	24	22	311 400
Latvia	2 229 641	65.0	4	2	1 114 800
Macedonia	2 077 328	17.8	4	4	519 300
The Netherlands	16 696 000	55.7	31	22	759 000
Portugal	10 636 979	54.5	29	21	506 500
Poland	38 200 037	50.2	137	114	335 100
Romania	19 042 936	57.7	22	12	1 586 911
San Marino	31 269	191.9	1	1	31 300
Saudi Arabia	26 316 704	11.5	30	4	6 533 000
Serbia	7 276 195	NA	11	5	1 455 200
Slovakia	5 404 322	78.6	6	4	1 351 000
Slovenia	2 050 189	11.2	5	2	1 025 094
Spain	46 152 '926	46.9	126	78	591 700
Sweden	9 415 570	78.	29	12	784 600
Switzerland	7 870 134	12.6	32	26	302 700
Turkey[b]	14 283 013	13.0	27	15	952 200
UK	63 141 700	NA	117	57	1 107 749
Ukraine	45 134 707	55.5	37	11	4 103 200

[a]In Austria, further 14 centres perform PPCI in STEMI patients for 1 up to 3 days 24 h within networks that offer a rotational system of open catheter networks (e.g. STEMI networks in Vienna, LINZ, Lower Austria South).
[b]Based on survey data in selected parts of the countries—see also *Table 1*.

Results

Utilization of primary percutaneous coronary intervention in 2007 and 2010/2011

Figures 1 and 4 show the use of PPCI in the participating 37 countries. Primary percutaneous coronary intervention utilization varied considerable between countries with a range from 23 to 884 PPCI procedures per 1 000 000 inhabitants (*Figure 1*). Countries with the highest utilization of PPCI per 1 000 000 were Austria, Bulgaria, Germany, the Netherlands, and Poland. Azerbaijan, Cyprus, Egypt, Georgia, Saudi Arabia, and Ukraine had the lowest utilization (*Figure 1*). Most countries had PPCI rates around 400–600 procedures per 1 000 000 inhabitants (*Figures 1* and *4*). Twenty-seven of the total 37 countries participated in the former survey. Major

Table 3 Crude in-hospital mortality (%) of ST-elevation myocardial infarction (STEMI)

Country	STEMI	STEMI treated with PPCI	STEMI treated with thrombolysis	STEMI receiving no reperfusion
Bulgaria	12	6.1	11	19
Denmark	6	3.1	NA	11
Hungary	10	6	13.5	15.5
Iceland	5.5	NA	NA	NA
Italy	4	2.5	2.5	6.2
Macedonia	4.3	2.2	6.5	8.7
Portugal	6.7	3.3	NA	8.5
Poland	3.0	4.4	25	11.5
Romania	9.9	4.4	8.3	17.1
Spain	6.3	5	NA	13.4
Sweden	7.1	4.8	5.9	26
UK	NA	4.4	NA	NA

Based on data from countries with access to a national PCI and STEMI registry.

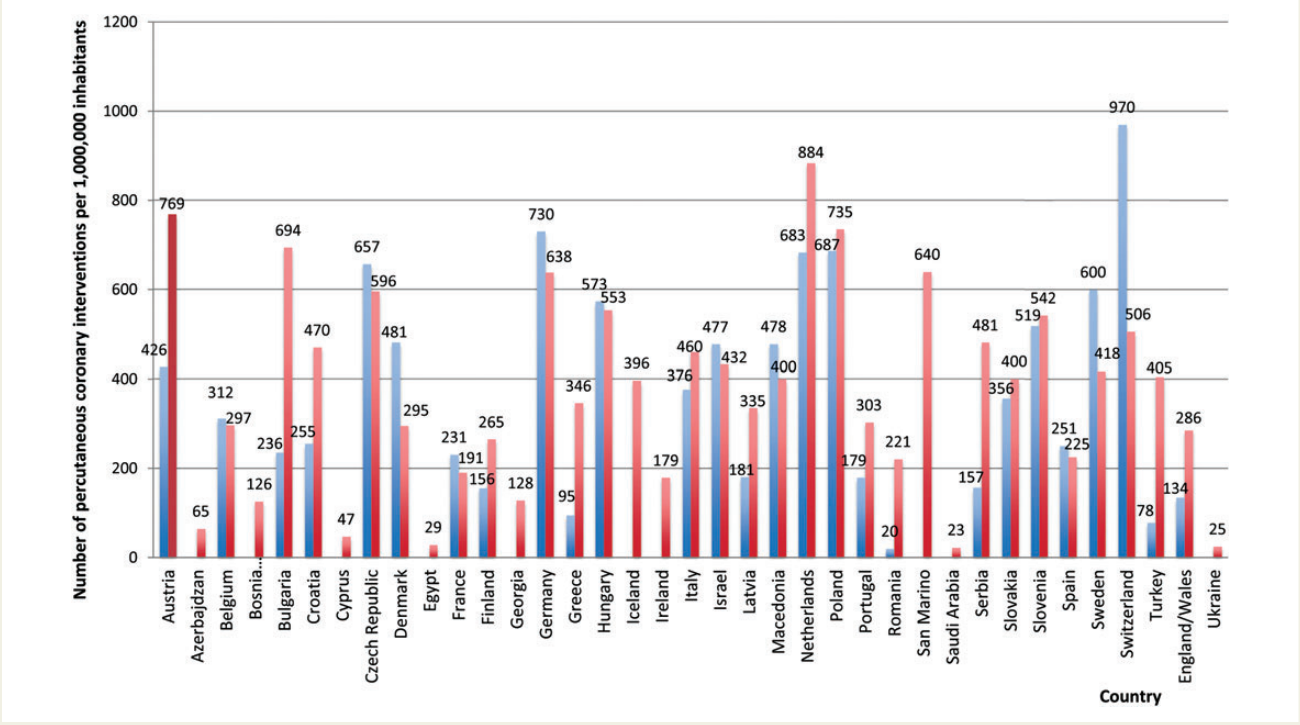

Figure 1 Primary percutaneous coronary interventions per 1 000 000 inhabitants in 37 ESC countries. Blue bars are data from 2007 and red bars are data from 2010/2011.

increases in PPCI utilization were observed in 13 countries: Austria, Bulgaria, Croatia, Greece, Italy, Latvia, the Netherlands, Portugal, Romania, Serbia, Turkey, and England/Wales (*Figure 1*). Countries like Denmark, France, and Sweden on the other hand experienced a decline in PPCI procedures.

Utilization of thrombolysis

The use of thrombolysis was highest in Bosnia and Herzegovina, Cyprus, Greece, and Serbia (*Figure 2*). The use was below 100 per 1 000 000 inhabitants in the majority of the countries.

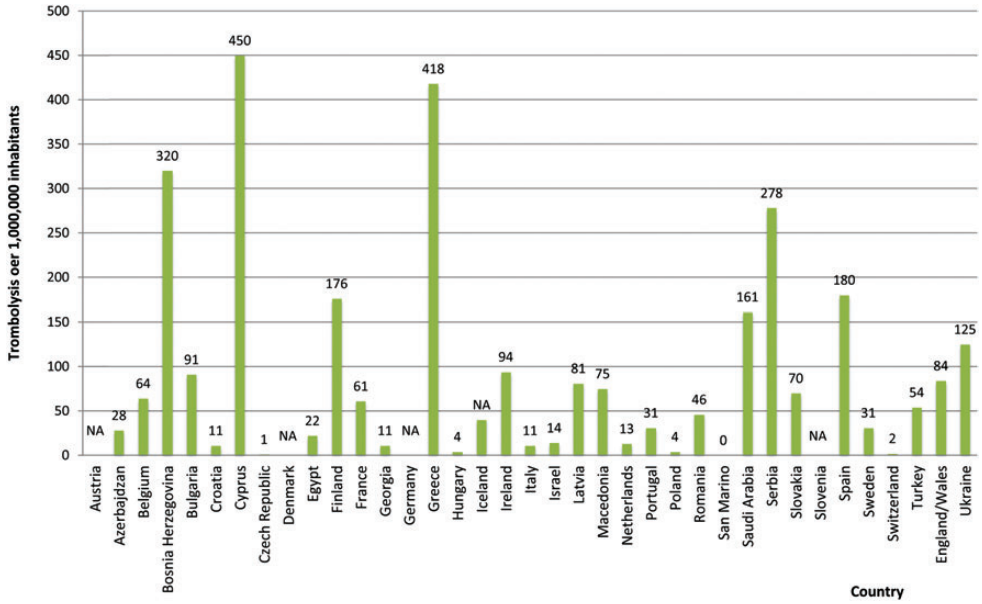

Figure 2 Thrombolysis per 1 000 000 inhabitants in 37 ESC countries 2010/2011.

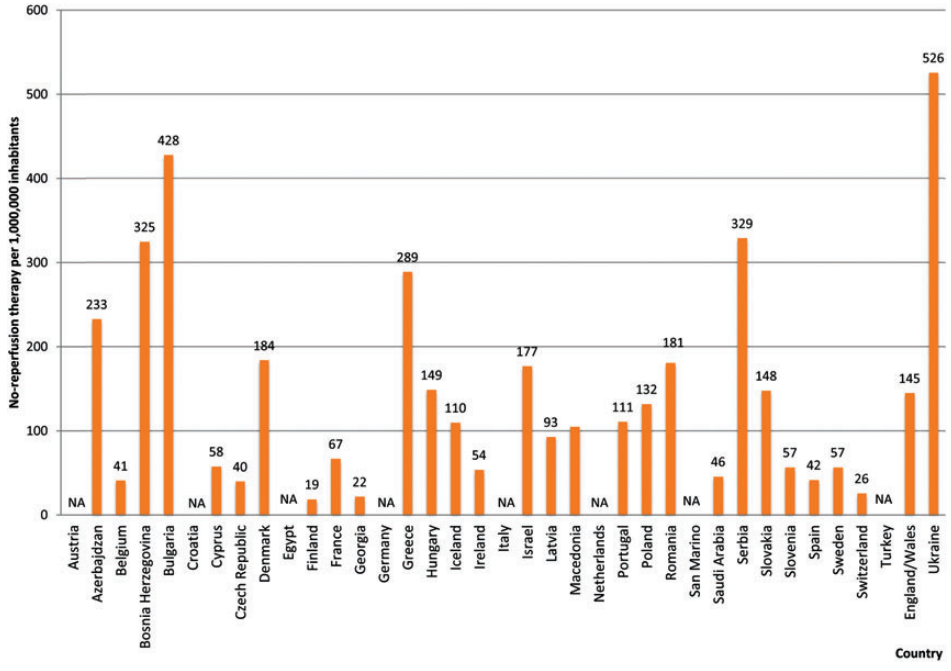

Figure 3 No reperfusion therapy per 1 000 000 inhabitants in 37 ESC Countries 2010/2011.

Number of non-reperfused patients

The number of non-reperfused patients ranged from 19 to 526 per 1 000 000 inhabitants (*Figure 3*). A large number of countries were unable to provide data on non-reperfusion.

Numbers of primary percutaneous coronary intervention centres and cardiologists

Table 2 summarizes the population of the countries, the number of board-certified cardiologists, the number of PPCI performing

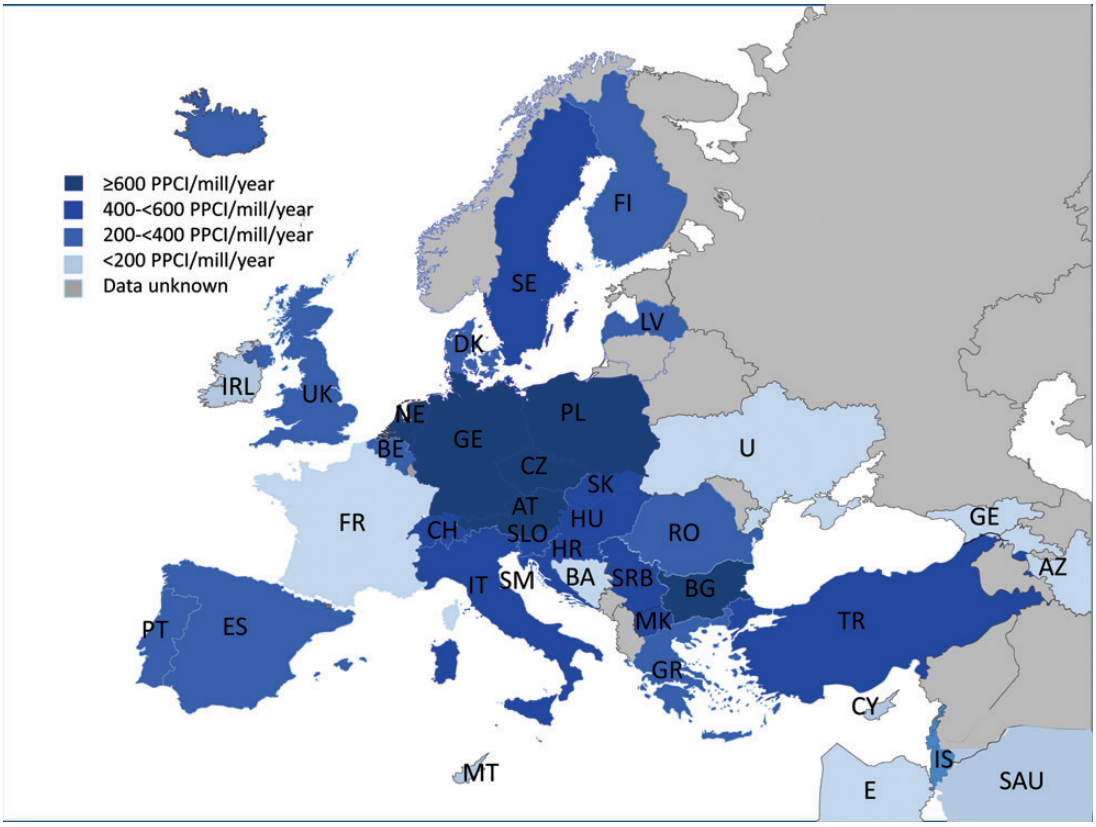

Figure 4 Numbers of Primary Percutaneous Coronary Interventions per 1 000 000 inhabitants 2010/2011 in 37 ESC member countries, grouped.

hospitals, the number of PPCI centres with a 24-h service 7 days a week (24/7), and the mean number of the population served by a 24/7 service PPCI centre for each country in the year 2011.

The mean number of board-certified cardiologists ranged from 0.2 in Azerbaijan to 243.8 board-certified cardiologists per 1 000 000 inhabitants in Greece (*Table 2*). There was no significant correlation between the number of cardiologists per 1 000 000 inhabitants and the number of PPCI procedures ($R = -0.0013$, $P = 0.99$).

The mean population served by a single PPCI centre with 24/7 services (*Table 2*) ranged from 31 300 inhabitants per centre (San Marino) to 6 533 000 inhabitants per centre (Saudi Arabia) (*Table 2*). The number of PPCI capable centres with 24/7 services was highest in Italy with 211 centres. In Cyprus, no PPCI centres existed at the time of data collection.

Mortality

Table 3 displays the in-hospital mortality for STEMI patients overall and the in-hospital mortality for STEMI patients treated with PPCI, thrombolysis, and patients receiving no reperfusion therapy. Overall in-hospital mortality in STEMI varied between 3% (Poland) and 10.0% (Hungary), whereas mortality for patients treated with PPCI was lower (range 2.2–6.1%). In countries with specific patient identifiers that allow robust-confirmation of patient-specific mortality, the reported mortality in STEMI patients treated with PPCI was 3.1% (Denmark) and 4.8% (Sweden) (*Table 3*).

Discussion

The main finding in our descriptive study of reperfusion therapy in 37 ESC countries is that large national variation in treatment strategies for patients admitted with STEMI still exists. Despite the fact that international guidelines have been recommending PPCI as the first-choice treatment for the last 10 years, this therapy is still not implemented throughout ESC countries. Moreover, a substantial number of patients are still not offered any reperfusion therapy. However, due to the variety of data collection methods and registry practices (*Table 1*), a direct comparison between countries should be performed with caution.

Utilization of primary percutaneous coronary intervention

Primary percutaneous coronary intervention as the first-choice treatment strategy is well implemented in most Northern, Western, and Central Europe countries, whereas the numbers of patients receiving this therapy still are low in some of the Southern and Eastern countries. These findings relate closely to those in the first survey based on data from 2007 published by Widimsky *et al.*[4] Twenty-seven of the 37 countries participated in this former survey. We found a major increase in the overall numbers of performed PPCIs in 13 of the countries compared with the data obtained in 2007. Especially in the majority of the countries that are participating in the Stent

for Life Initiative (Bulgaria, Greece, Italy, Portugal, Romania, Serbia, Spain, and Turkey), an important increase was evident.[3,9,10] Moreover, England/Wales reports a remarkable increase in the number of patients treated with PPCI moving from <40% of the STEMI population treated with PPCI in 2006 to >90% in 2011.[11] Countries like Denmark, Sweden, and Switzerland experienced a significant decline in PPCI utilization. On an explanation for this, evident in Denmark, would be the fact that the data from the survey in 2007/2008 were based primarily on an expert estimate, whereas that for the present survey was based exclusively on national registry data. Another plausible explanation is the decline in the incidence of STEMI over the past years in some western countries, most likely due to secondary better preventive treatments.[12–14] Explaining variation in treatment utility and comparing levels across countries remain a difficult task since it is highly influenced by multiple factors.

A gross estimate of 600 PPCI procedures per 1 million inhabitants has served as the recommended treatment goal in the development of a STEMI treatment strategy.[15] The major barrier to this type of goal setting is the lack of good nationwide registries that allow inter- and cross-country comparisons at the patient level. The underlying population demand is often unknown and such information will be a prerequisite to address the full diversity of access to treatment and to set specific treatment goals for individual countries. The importance of considering differences in the need for PPCI is apparent across Europe, where demographics vary highly and where death rates from ischaemic heart disease (both sexes, all ages) are twice as high in the UK as in Portugal.[16,17] For example, in Ireland, the ratio of elderly persons given as the number of >65 year old divided by the number of persons <65 is 17.2%, whereas in Italy this ratio is 30.9% (2011, Eurostat, Population statistics).[6,12,16] This stresses the need for good quality data at the patient level with continuous monitoring of incidence and treatment outcomes.[6,12] Future studies could benefit from reporting age standardized rates in order to make data more comparable. Also, the underlying illness burden of the population expressed as the level of co-morbidity (e.g. existing diabetes and hypertension) may vary, and influence the demand for PPCI. For example, in Saudi Arabia the percentage of people with acute coronary syndrome (ACS) suffering from diabetes is as high as 58% (2011),[18] whereas the Danish Health and Medicines Authority reports a prevalence among patients with ACS in Denmark around 30%. However, most literature finds that supply factors are the major drivers of implementation also for PPCI.[19–22] Newer studies have found that the number of physicians is associated with the level of PPCI utilization.[21,22] In our study, we found no correlation between the number of cardiologist and the number of PPCI utilization.

However, previous studies have not only shown that regions that spend more on health care on average have sicker patients, but also that higher levels of illness explain only a fraction of the overall difference in regional variations.[23–27] Another explanation for the observed variations could be the countries reimbursement schemes. Some studies have acknowledged the important influence of payment methods on technology utilization.[28,29] The reimbursement schemes for both physicians and hospitals can be strong incentives for treatment utilization and may explain some of the observed variation in PPCI utilization. Moreover, the STEMI incidence will be affected by the capability of early and correct diagnosis of STEMI. Countries with newly established registries and STEMI management strategies will most likely experience a rise in STEMI prevalence and incidence for some years due to more patients being diagnosed and registration improved. Clearly, there is a need for a re-evaluation of the recommended level of PPCI usage adjusted to the context of the country.

One other important factor that may, in part, account for the observed differences in PPCI utilization is the definition of PPCI. Some countries included procedures performed >12 h after symptom onset,[21] and also some patients with non-STEMI or cardiac arrest undergoing acute PCI. Furthermore, the data collection methods varied substantially. Some countries did provide samples or extrapolations of their STEMI total population, and thus, the actual level of PPCI in the countries must be interpreted carefully. For example, utilization rates for PPCI and thrombolysis (*Figure 1* and *2*) were considerable higher in Bulgaria than in Slovakia, despite a similar level of acute myocardial infarction discharge rates per 100 000 population (178.2 vs. 177.0, 2010, Eurostat, Health statistics).[16] Moreover, in some countries, patients treated in private hospitals may not have been included. Differences in registration practice may therefore to some extent explain the reported differences (*Table 1*). However, we do not believe that differences in data definition and data collection methods fully explain our findings of a persisting large variation in reperfusion therapy.

Thrombolysis

Thrombolysis is still widely used in some Southern and Eastern countries, whereas countries like Denmark, Czech Republic, the Netherlands, and Sweden almost have stopped using thrombolysis in STEMI patients. One plausible explanation for the existing widespread use of thrombolysis is that several countries do not have the required infrastructure and timely access to catheterization laboratories with specialized personnel.[9,30] In areas remote from PCI facilities where PPCI cannot be delivered within the recommended time limit the benefit of thrombolysis is well established and remains an important reperfusion strategy.[1,31]

Thrombolysis should preferably be administered in the prehospital setting and should be followed by transfer to a PCI centre as soon as possible for urgent (rescue) or subacute coronary angiography.[1,32] The optimal timing of routine angiography following successful thrombolysis is not settled, but recent trials suggest a time window of 2–12 h.[1] A well-organized system of care with clear treatment protocols and coordinated transfer systems is necessary for identifying treatment-eligible patients for on-site thrombolysis or transfer for PPCI, as treatment is highly dependent on time. Studies have shown that system delay (time from first medical contact to initiation of reperfusion) is strongly associated with mortality, and the risk of readmission to hospital with congestive heart failure.[33–36] As stated in the newly published STEMI guidelines from ESC, the time from first medical contact to reperfusion with PPCI should not exceed 120 min, and indeed, we should attempt to obtain even shorter time delays.[1]

No reperfusion

STEMI patients who do not receive reperfusion therapy have a poor outcome.[37] Our survey demonstrates that a substantial proportion of STEMI patients still are not receiving any reperfusion therapy

(*Figure 3*), which highly stresses the need for actions to improve these figures. Under-utilization of eligible STEMI patients is evident and have been reported to compress 23–30%.[38,39] The reported numbers of non-reperfused patients in our study is hampered by the fact that have very few registries on STEMI incidence exist making it difficult to make valid estimates. Delays in admission to the hospital, certain high-risk clinical features and substantial co-morbidity have all been shown to be associated with lower utilization rates of reperfusion therapy.[38,39] Moreover, the definition of non-reperfused patients may differ. For example, in Israel, the ACSIS survey showed that 33% of the examined patients had spontaneous reperfusion before reaching the catheterization laboratory and, therefore, was registered as a non-reperfused patient. In other studies, non-reperfused patients are the patients who are diagnosed after >12 h of symptom onset. It has been suggested that achieving late coronary patency in situations where patients present late might still have beneficial outcomes with PPCI. However, this is still debated.[1,32] Getting patients to call for medical help as soon as possible after symptom onset is a challenge in many countries.[9] Therefore, efforts are highly needed to increase public knowledge on the symptoms of myocardial infarction and of the awareness for immediate contact to the emergency medical system in order to shorten patient delay.

Organization of reperfusion therapy

The number of PPCI capable centres with 24/7 service and the number of cardiologists per 1 million inhabitants also varied considerable between countries. Earlier studies, like the GRACE registry, reported that the numbers of teaching hospitals and hospitals with catheterization laboratories were indicators of a higher PPCI utilization.[40] A high use of PPCI most likely depends on the presence of the necessary skills needed to perform the procedure and the availability of appropriate facilities and equipment.[41,42] Furthermore, it is possible that hospitals using PPCI have better resource allocation and an organization that allow for better overall management of all aspects of acute STEMI treatment, which most likely will lead to better outcomes and reduced health-care system delay. The formation of STEMI networks involving emergency medical services, non-PCI hospitals, and PPCI centres could be necessary to implement PPCI services effectively.[1,32,43] Besides single tertiary centres serving a specific area for 24 h, some countries and regions have developed rotational systems of STEMI care, in which three and up to five interventional cardiology centres share the PPCI function during night time. These systems have shown to be cost-effective with comparable low mortality rates as single tertiary centres offering 24/7 services, and at the same time guarantees that only experienced interventionalists are on duty.[44] Most importantly, these STEMI networks have been shown to reduce the number of non-reperfused patients. The population served by a centre must be sufficient to maintain the competency of the centre. However, setting meaningful thresholds for minimum numbers of PPCI per year to maintain the competency of both the hospital and the operator is difficult and still remains a question for future research and discussion.[45,46]

Mortality

In-hospital mortality for STEMI patients treated with PPCI varied between 3.1 and 6.1%. The reported in-hospital mortalities are consistent with evidence from other observational studies.[2,3,47,48] However, comparison of in-hospital mortality across populations is fraught with problems. Mortality data are highly dependent on the population studied and the methodologies for data collection and coding. For example, the overall mortality in patients with cardiogenic shock (usually 8–10% of patients in STEMI networks) is 40–50%, and the number of these patients will influence the mortality rate positively or negatively depending on their inclusion or absence in the registries. In well-organized networks, the in-hospital and 30-day mortality ranges from 3 to 5%.[43] The newly published FAST-MI trial from France reported a decrease in 30-day mortality from 13.7 to 4.4% in the period 1995 to 2010.[3] Moreover, they noted that overall mortality decreased irrespective of use and the type of reperfusion therapy, including the patients who did not receive any reperfusion therapy,[3] indicating that other factors such as better preventive drug therapy and changes in lifestyle are important.

Why is primary percutaneous coronary intervention not implemented?

The variation in uptake of PPCI appears to be present worldwide, and is not explained solely by economic incentives, illness severity, or patient preferences. The scant evidence within the field indicates that the barriers for PPCI implementation are a complex mix of medical, organizational, patient-related, regulatory, and economic factors.[6,21] Many factors still need to be addressed in order to understand and explain the remaining large variation in treatment utilization across Europe. The Stent for Life Initiative is, in our opinion, a good example of a joint multi-level effort identifying barriers at a national and regional level in order to change practice, and would be an example for other countries to follow.

Strength and limitations

The major strength of the study is that we were able to include a large number of countries that provided up-to-date information on the use of reperfusion therapy. STEMI is a common and well-defined clinical condition worldwide, allowing international comparison. Moreover, we provide updated information on the number of hospitals with PPCI facilities and the number of cardiologists for each country.

The major limitation of our study is the quality of the data, and several points should be highlighted. First, discrepancies in the way the data were collected; the coding of STEMI and in the definition of PPCI in the 37 countries are clearly hampering our study and may lead to both under- and overestimation of the actual reperfusion utilization and thus make cross-country comparisons difficult. Secondly, only a minority of the countries have mandatory registries, and outcomes are not based on an exhaustive collection of the STEMI population in the whole country. Moreover, the majority of countries participation in the survey changed or expanded their registration since the previous survey conducted in 2007/2008, which even makes within country comparisons difficult. Incomplete or non-compulsory reporting from hospitals may bias the factual size of the reported inequality, but the size and direction of the bias is unknown. Furthermore, data in four countries were based on best expert estimates and extrapolations, which most likely will lead to an overestimation of the actual use. Countries not participating in the survey may

be countries with less-developed STEMI programmes. This would underestimate the actual level of variation across Europe. The survey makes it possible for countries to highlight their problems regarding PPCI implementation. Mortality data are highly affected by the underlying population, e.g. the percentage of patients with out-of-hospital cardiac arrest and shock. Unfortunately, our study was based on aggregated country-level data with no access to detailed patient-level data. Thus, comparison of mortality data across countries should be done with caution.

Since STEMI incidence in most countries is unknown, we choose to present reperfusion therapies as the numbers of patients treated with the different modalities per million inhabitants instead of percentage. It can be argued that this is a crude instrument especially when populations are diverse. However, we feel that this is the most valid estimation we could obtain.

While these findings must be interpreted with caution given the limitations of the study, and the difficulties with cross-country comparisons, this mapping of the current status of reperfusion therapy across a large number of European countries is nevertheless instructive in presenting a picture of a striking international variation in the treatment strategies in patients admitted with STEMI.

Conclusions and future perspectives

In conclusion, our study demonstrates striking differences in the management of patients admitted with STEMI in 37 ESC countries. It seems that a significant deviation from the guideline recommendations is still prevailing, and an understanding of the reasons behind under-utilization of reperfusion therapy is a prerequisite for reducing or eliminating such gaps in healthcare.

In an attempt to reduce differences in a number of European countries, the Stent for Life Initiative, supporting the implementation of timely PPCI was established in 2008.[15,49] The participating countries already report striking rises in PPCI utilization, reduction in mortality, and an overall more effective management/organization of the STEMI treatment system, which strongly calls for a continuation of a strategy of implementation and supports of countries with low activities.[9,49]

A major challenge for improvement of the care and outcome of STEMI patients in Europe is the lack of accurate and comprehensive data. The availability of complete reperfusion data and patient outcome is a prerequisite to address the full diversity of access to treatment in order to improve treatment availability and outcomes for STEMI patients in the future. Systematic use of large data-based registries on STEMI treatment is highly needed. Also, the establishment of key indicators underpinned by key items of data with data definitions and clear analytical steps as used in other organizations might be helpful.

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CARDIOVASCULAR FLASHLIGHT

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Papillary fibroelastoma of the mitral valve as an unusual cause of myocardial infarction in a 20-year-old patient

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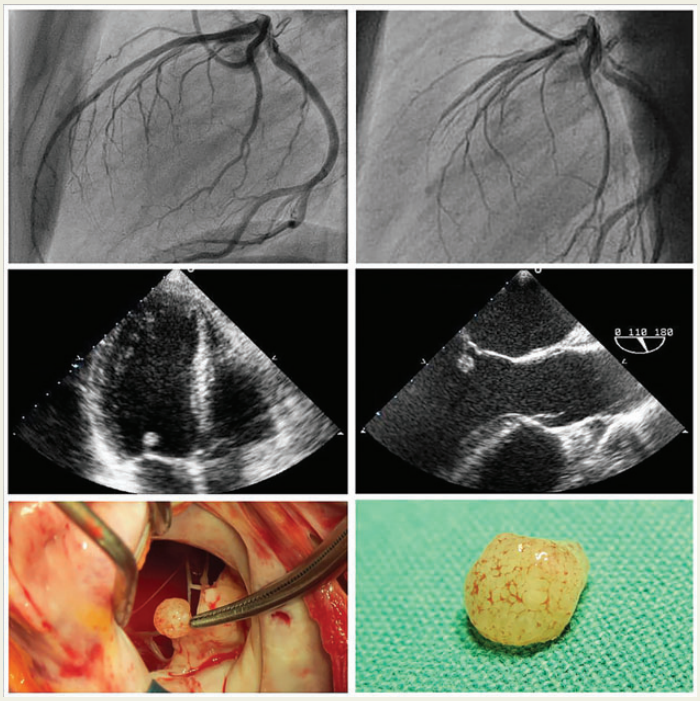

The incidence of primary cardiac tumours is <0.1% and papillary fibroelastomas are relatively rare when compared with myxomas and lipomas. Papillary fibroelastoma is generally small and single, occurs most often on valvular surfaces, and may be mobile. Despite the embolic potential of primary cardiac tumours, they are extremely uncommon cause of ischaemic vascular accidents. Patients with smaller tumours, situated on the aortic valve and in the left atrium, with minimal symptomatology and no evidence of mitral regurgitation have a higher risk of embolism. Several causes of myocardial infarction in young patients, mostly non-atheromatous origin, have been described. These are congenital coronary artery anomalies, aneurysms, spontaneous dissection, myocardial bridging, septic coronary emboli or bacteraemia, and paradoxical embolization through a patent foramen ovale. Only a few cases of acute coronary syndrome caused by papillary fibroelastoma were reported.

A 20-year-old male patient with no cardiovascular risk factors, with a history of recurrent pre-syncope was admitted to the hospital with ST-segment elevation myocardial infarction. An amputation of the left descending coronary artery was revealed and a thrombus-like mass was removed.

A following transthoracic echocardiogram showed abnormal contraction of the apex and interventricular septum and a round, hyperechoic, well-demarcated, homogenous, non-mobile tumour of 5 mm in diameter attached to the atrial side of mitral annulus, with no influence on valvular function. Transoesophageal echocardiography revealed no other masses in the heart chambers or great arteries and no patent foramen ovale. Surgical excision of the tumour was successfully performed 4 weeks after myocardial infarction and postoperative course was uncomplicated. The histological examination revealed papillary fibroelastoma.

We believe that in young patient with acute coronary syndrome echocardiography should be performed prior to initiating reperfusion therapy.