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.
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.

Methods and results

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.

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
Table 1  Description of country data sources

<table>
<thead>
<tr>
<th>Country</th>
<th>Data from the year</th>
<th>Existing national PCI registry</th>
<th>Existing regional PCI registry</th>
<th>Existing national STEMI registry</th>
<th>Existing regional STEMI registry</th>
<th>Expert estimates only</th>
<th>Completeness of STEMI capturing per period/percentage of STEMI population covered by the registry</th>
<th>Comments to data content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria*</td>
<td>2011</td>
<td>Austrian PCI registry</td>
<td>Wilhelminen Hospital Vienna</td>
<td>No</td>
<td>Vienna, STEMI registry</td>
<td>x</td>
<td>90% (estimate)</td>
<td>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</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>2011</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>x</td>
<td></td>
<td>50% STEMI database 100% PCI database 100%</td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>2011</td>
<td>Belgian PCI registry</td>
<td>No</td>
<td>Belgian STEMI registry</td>
<td>No</td>
<td>x</td>
<td>70% STEMI database 50% PCI database 100%</td>
<td></td>
</tr>
<tr>
<td>Bosnia and Herzegovina</td>
<td>2011</td>
<td>Started November 2011</td>
<td>No</td>
<td>Started November 2012</td>
<td>No</td>
<td>x</td>
<td>70% STEMI database 50% PCI database 100%</td>
<td></td>
</tr>
<tr>
<td>Croatia*</td>
<td>2011</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>&gt;90% Crosstie Institute for Public Health and regional and in-hospital ACS/STEMI/PPCI registries</td>
<td>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</td>
</tr>
<tr>
<td>Cyprus</td>
<td>2009</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>x</td>
<td>NA</td>
<td>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</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>2011</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>92% Register + approximation based on current and older data</td>
<td>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</td>
</tr>
<tr>
<td>Denmark</td>
<td>2010</td>
<td>The Danish Heart Registry</td>
<td>The Western Denmark Heart Registry, PATS (The Eastern Denmark Heart Registry)</td>
<td>The Danish National Patient Registry</td>
<td>The Danish National Patient Registry</td>
<td>100%</td>
<td>100% Register + approximation based on current and older data</td>
<td>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</td>
</tr>
<tr>
<td>Egypt</td>
<td>2011</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>36%, 31 million people</td>
<td>Based on the 1st Phase of Egyptian Stent For Life registry (9 months). Four areas only: Cairo, Alexandria, Delta, and Canal. Fourteen cath labs</td>
</tr>
<tr>
<td>Finland</td>
<td>2011</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes—some</td>
<td>x</td>
<td>Near 100% PC1 data based on registry data, STEMI data based on expert estimates</td>
<td>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</td>
</tr>
</tbody>
</table>

Continued
<table>
<thead>
<tr>
<th>Country</th>
<th>Data from the year</th>
<th>Existing national PCI registry</th>
<th>Existing regional PCI registry</th>
<th>Existing national STEMI registry</th>
<th>Existing regional STEMI registry</th>
<th>Expert estimates only</th>
<th>Completeness of STEMI capturing per period/percentage of STEMI population covered by the registry</th>
<th>Comments to data content</th>
</tr>
</thead>
<tbody>
<tr>
<td>France(^a)</td>
<td>2011</td>
<td>ONACI</td>
<td>RICO, Cardio ARIF, ORBI, Center registry, PACCA registry, Alpine registry</td>
<td>No</td>
<td>RICO, Cardio ARIF, ORBI, Center Registry, PACCA registry, Alpine registry</td>
<td>35%</td>
<td>Based on the FAST-MI survey data</td>
<td>Numbers are based on data from only five PCI centres. (insured patients only)</td>
</tr>
<tr>
<td>Georgia</td>
<td>2011</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>x</td>
<td></td>
<td>Activity numbers are based on BQS: AQUA-Institut, data collection is mandatory, Staff numbers are based on Bruckenberger, the German Heart Statistics 2011</td>
</tr>
<tr>
<td>Germany</td>
<td>2011</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
<td></td>
<td>Data based on Stent for Life Registry, Hellenic PCI Registry</td>
</tr>
<tr>
<td>Greece</td>
<td>2011</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>14.5%</td>
<td></td>
<td>Data are based on GISE database, thrombolysis, and no reperfusion are based on BLITZ-4 (2011) 92% PCI 100% STEMI 95%</td>
</tr>
<tr>
<td>Hungary</td>
<td>2011</td>
<td>Yes</td>
<td>Yes</td>
<td>Partially</td>
<td>Yes</td>
<td></td>
<td>50% Snapshot survey (2011) 92% PCI 100% STEMI 95%</td>
<td>SWedeHEART. Data on the use of thrombolysis are based on expert estimates</td>
</tr>
<tr>
<td>Iceland</td>
<td>2011</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>13.5% (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</td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>2011</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
<td>Data are extrapolated (i.e. six times) from a 2-month national ACS surveillance</td>
<td>ISRAEL ACSIS 2010 National ACS Registry</td>
</tr>
<tr>
<td>Israel</td>
<td>2010</td>
<td>Yes</td>
<td>Record PCI</td>
<td>1—ACtIS ACS</td>
<td>1 Recode PCI</td>
<td></td>
<td>Data are based on GISE database, data on thrombolysis, and no reperfusion are based on BLITZ-4</td>
<td>ISRAEL ACSIS 2010 National ACS Registry</td>
</tr>
<tr>
<td>Italy</td>
<td>2010</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>BLITZ 1 (2 weeks snapshot in &gt;90% Italian CCUs; BLITZ-4 a weeks snapshot representative of approximately one-fifth of total CCUs)</td>
<td>Data are based on GISE database, data on thrombolysis, and no reperfusion are based on BLITZ-4</td>
</tr>
<tr>
<td>Country</td>
<td>Year</td>
<td>Reperfusion</td>
<td>Door-to-Needle</td>
<td>PCI Participation</td>
<td>Reperfusion Rate</td>
<td>Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>-------------</td>
<td>----------------</td>
<td>-------------------</td>
<td>----------------</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latvia</td>
<td>2011</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>90%</td>
<td>Based on national registry.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macedonia</td>
<td>2011</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>85%</td>
<td>Based on expert estimate and extrapolation of data from 18 interventional centres.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>2011</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>2011</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>2011</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>PL-ACS registry, national PCI database, thrombolysis, and number of patients not receiving any reperfusion are based on expert opinion.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Romania</td>
<td>2011</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>70%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Marino</td>
<td>2011</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Based on RO-STEMI.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>2011</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serbia</td>
<td>2011</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>National registry for ACS covers all hospitalized ACS patients in Serbia.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td>2011</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>80–90% Based on a 2-month snapshot covering 90% of hospitals. The results are multiplied by six to get 1-year data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovenia</td>
<td>2011</td>
<td>No</td>
<td>In each CL</td>
<td>No</td>
<td>In each CL</td>
<td>100% National registry for ACS. Clinical Centre of Serbia PPCI registry, National registry for ACS, Annual cath-lab reports of all PCI centres.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>2010</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>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).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>2011</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>100% Swedeheart, HIA.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>2011</td>
<td>No</td>
<td>No</td>
<td>AMIS plus</td>
<td>AMIS plus ca. 30%</td>
<td>Information based on voluntarily hospitals participation in AMIS Plus Registry.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>2011</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Data sent from 25 pilot cities of SFL initiative.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>2010 and 2011</td>
<td>Yes and Yes</td>
<td>Yes and Yes</td>
<td>100%</td>
<td>BCIS PPCI data for all UK 2011. MINAP data for 2010 England and Wales—thrombolysis.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ukraine</td>
<td>2011</td>
<td>Yes (covering just 75%)</td>
<td>No</td>
<td>No</td>
<td>NA</td>
<td>Information based on data from ‘Ukrainian Register of Percutaneous Coronary Interventions’, reporting the Ministry of Health. Personal communication with PCI centres.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CCU, Critical Care Unit; CL, County Level; HIA, Health Impact Assessment.

*Based on the same data sources as the survey published in 2010."
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 considerably 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
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.

<p>| Table 3 Crude in-hospital mortality (%) of ST-elevation myocardial infarction (STEMI) |
|-----------------------------------------------|-----------------|------------------|------------------|------------------|</p>
<table>
<thead>
<tr>
<th>Country</th>
<th>STEMI</th>
<th>STEMI treated with PPCI</th>
<th>STEMI treated with thrombolysis</th>
<th>STEMI receiving no reperfusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>12</td>
<td>6.1</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>Denmark</td>
<td>6</td>
<td>3.1</td>
<td>NA</td>
<td>11</td>
</tr>
<tr>
<td>Hungary</td>
<td>10</td>
<td>6</td>
<td>13.5</td>
<td>15.5</td>
</tr>
<tr>
<td>Iceland</td>
<td>5.5</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Italy</td>
<td>4</td>
<td>2.5</td>
<td>2.5</td>
<td>6.2</td>
</tr>
<tr>
<td>Macedonia</td>
<td>4.3</td>
<td>2.2</td>
<td>6.5</td>
<td>8.7</td>
</tr>
<tr>
<td>Portugal</td>
<td>6.7</td>
<td>3.3</td>
<td>NA</td>
<td>8.5</td>
</tr>
<tr>
<td>Poland</td>
<td>3.0</td>
<td>4.4</td>
<td>25</td>
<td>11.5</td>
</tr>
<tr>
<td>Romania</td>
<td>9.9</td>
<td>4.4</td>
<td>8.3</td>
<td>17.1</td>
</tr>
<tr>
<td>Spain</td>
<td>6.3</td>
<td>5</td>
<td>NA</td>
<td>13.4</td>
</tr>
<tr>
<td>Sweden</td>
<td>7.1</td>
<td>4.8</td>
<td>5.9</td>
<td>26</td>
</tr>
<tr>
<td>UK</td>
<td>NA</td>
<td>4.4</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

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.

**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.
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.

**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...
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. 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. 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.

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. 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. 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). This stresses the need for good quality data at the patient level with continuous monitoring of incidence and treatment outcomes. 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), 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. Newer studies have found that the number of physicians is associated with the level of PPCI utilization. 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. 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. 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, 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). 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. 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. Thrombolysis should preferably be administered in the pre-hospital setting and should be followed by transfer to a PCI centre as soon as possible for urgent (rescue) or subacute coronary angiography. The optimal timing of routine angiography following successful thrombolysis is not settled, but recent trials suggest a time window of 2–12 h. 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. 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.

**No reperfusion**

STEMI patients who do not receive reperfusion therapy have a poor outcome. Our survey demonstrates that a substantial proportion of STEMI patients still are not receiving any reperfusion therapy.
reinterventionalists are on duty. Most importantly, these STEMI net-

24/7 services, and at the same time guarantees that only experienced

with comparable low mortality rates as single tertiary centres offering

during night time. These systems have shown to be cost-effective

developed rotational systems of STEMI care, in which three and up

serving a specific area for 24 h, some countries and regions have

After symptom onset is a challenge in many countries. There-

the hospital, certain high-risk clinical features and substantial co-

number 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

to the hospital, certain high-risk clinical features and substantial co-

morbidly have all been shown to be associated with lower utilization

rates of reperfusion therapy. 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

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. Getting patients to call for medical help as soon as pos-

sible after symptom onset is a challenge in many countries. Therefore,
efforts are highly needed to increase public knowledge on the

symptoms of myocardial infarction and of the awareness for immedi-

ate 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 consid-

erable 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 utiliza-

tion. 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. Furthermore, it is pos-

sible 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 forma-

tion of STEMI networks involving emergency medical services,

non-PCI hospitals, and PPCI centres could be necessary to imple-

ment PPCI services effectively. 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. Most importantly, these STEMI net-

works 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.

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. 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 ex-

ample, 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%. 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. 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,

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. Many factors still need to be addressed in order to under-

stand and explain the remaining large variation in treatment utiliza-

tion 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. Sec-

ondly, 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 regis-

tration 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 esti-

mates and extrapolations, which most likely will lead to an overesti-

mation 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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References


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 post-operative 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.