

Primary percutaneous coronary intervention during on- vs off-hours in patients with ST-elevation myocardial infarction. Results from EUROTRANSFER Registry

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Abstract

Background: Primary percutaneous coronary intervention (PPCI) is regarded as the treatment of choice for ST elevation myocardial infarction (STEMI) patients. It has been emphasised that only experienced centres with round-the-clock cathlab facilities should perform PPCI. Some investigators have doubted whether PPCI performed during 'off-hours' is as effective and safe as that performed during regular hours. Papers supporting both possibilities have been published.

Aim: To investigate whether off-hours PPCI is associated with impaired immediate and long-term outcomes based on a contemporary European registry study.

Methods: Consecutive data on STEMI patients referred for PPCI in hospital STEMI networks between November 2005 and January 2007 was gathered. Patients were divided into two groups: PPCI performed during 'on-hours' and PPCI performed during 'off-hours' (including Saturdays and Sundays).

Results: Data from a total of 1,650 patients were collected in the EUROTRANSFER Registry. There were 1,005 patients in the off-hours group (61%) and 645 (39%) patients in the on-hours group. Patients in both groups did not differ in baseline demographics. Thrombolysis before admission to cathlab was more frequently administered to patients off-hours (4.1% vs 2.3%, $p = 0.041$). The PPCI complications were rare and occurred in similar frequency in the studied groups. Time from chest pain onset to diagnosis of STEMI was shorter in the off-hours group (173 ± 210 vs 183 ± 187 , $p = 0.007$). In-hospital mortality was 3.4% in the on-hours group and 4.3% in the off-hours group (NS).

Conclusions: The PPCI performed in high-volume, experienced invasive cardiology centres in Europe during off-hours is associated with a comparable outcome and safety profile as PPCI performed during regular working hours.

Key words: myocardial infarction, primary percutaneous coronary intervention, registry, off-hours

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INTRODUCTION

Primary percutaneous coronary intervention (PPCI) is regarded as the optimal treatment (recommendation IA) for ST elevation myocardial infarction (STEMI) patients, provided that

it is performed promptly and in accordance with the current European guidelines [1]. It has been emphasised that only experienced interventional teams should perform PPCI in centres with round-the-clock cathlab facilities. It has been

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observed that high-volume PCI centres with more experienced physicians tend to have lower complication rates and mortality [2].

Creating hospital networks containing round-the-clock invasive cardiology centres on duty has helped shorten delays in STEMI patients and significantly reduce mortality [3–5]. That, however, means that the reference centres for PPCI must be equipped with experienced staff all day and night and during the weekend. Some investigators have raised doubts as to whether PPCI performed during off-hours is as effective and safe as that performed during regular hours [6, 7]. That could possibly make other reperfusion therapies, such as thrombolysis comparable to PPCI in their effect for this group of patients. However, on the other hand, there is also evidence that such differences are negligible and that off-hours PCI for STEMI is both feasible and safe [8, 9].

Our aim of the study was to investigate whether PPCI performed during off-hours is associated with impaired immediate and long-term outcomes based on a contemporary European registry study.

METHODS

The EUROTRANSFER Registry was a European (seven countries), prospective, multicentre registry which enrolled STEMI patients in 2005–2007. Detailed study design, rationale and results have already been published in several peer-reviewed papers [10–12]. The EUROTRANSFER Registry was registered at ClinicalTrials.gov (NCT00378391), complied with the Declaration of Helsinki, and has been approved by the Jagiellonian University Bioethics Committee in Krakow, Poland.

Study group

There were 1,650 patients enrolled in this registry. The following two groups of patients were identified for the purpose of this analysis: (1) patients admitted during on-hours, which were defined as being admitted to the cathlab facility on Monday–Friday between 8am–4.59pm, and (2) patients admitted during off-hours, defined as being admitted to the cathlab facility between Friday 5pm and Monday 7.59am and during the night on Monday–Friday (5pm–7.59am). Cut-off times for the differentiation of on- and off-hours were based on participating centres' schedules and common everyday practice.

Study outcomes

The main study outcome for this analysis included in-hospital and one-year death (cardiovascular and all-cause), combined end-point of ischaemic events (death, repeated MI and urgent revascularisation [CABG and/or PCI]) in-hospital and at 30 days as well as surrogate angiographic and ECG parameters. The PCI complications during index procedure were also reported.

Statistical methods

Data were analysed according to the established standards of descriptive statistics. Categorical variables were compared by a maximum likelihood χ^2 test with Fisher's exact test if applicable. Continuous variables were assessed for normality and are reported as mean $\pm$ SD. Continuous variables were compared by two-tailed t-test or the Mann-Whitney U-test. Kaplan-Meier one-year survival curves were plotted for on- vs off-hours groups using log-rank test to test for differences. Statistical significance was defined as a p value of less than 0.05. All statistical analyses were performed using STATISTICA 9.0 software (Statsoft Inc., Tulsa, OK, USA).

RESULTS

There were 1,005 patients in the off-hours group (61%) and 645 (39%) patients in the on-hours group. Baseline demographics, clinical characteristics and past medical history were similar in both groups and are presented in Table 1. Concomitant medications in the precathlab phase and details of angiography and PCI are presented in Table 2. Thrombolysis before admission to cathlab was more frequently administered to patients during off-hours. The PCI complications like distal embolisation, no-reflow, tamponade, and side branch occlusion were rare, and occurred in similar rate in the studied groups. Time from chest pain onset to diagnosis of STEMI by medical staff was shorter by a mean of 10 min during off-hours (Table 3). In-hospital mortality was 3.4% in the on-hours group and 4.3% in the off-hours group (NS) (Table 4). The Kaplan-Meier one-year survival curves for both study groups are presented in Figure 1.

DISCUSSION

Providing a round-the-clock PPCI service is a logistical challenge not only for cathlab personnel but also emergency medical services, and often for local government. It usually takes years to train competent doctors and nurses to work on a 24/7 PPCI schedule. On the other hand, experience and high volume result in improved outcomes for patients and it is a profitable enterprise overall [2, 3]. This is also why current guidelines insist on experience as a prerequisite for performing PPCI procedures for STEMI patients [1].

The question that arises is whether we are capable of providing a similar service in terms of efficacy and safety to STEMI patients during off-hours as well? This issue is of great importance because approximately two in every three STEMI patients are admitted to cathlab facilities outside the normal working hours [8, 9]. In the EUROTRANSFER Registry, 61% of patients arrived at the cathlab during off-hours. Current guidelines do not differentiate treatment strategies between routine and night hours. We cannot expect solid evidence in this matter, so we have to rely on registry studies since no randomised clinical trial can ever be held due to ethical reasons.

Table 1. Baseline demographics and clinical status on admission to PCI centre

	On-hours (n = 645)	Off-hours (n = 1005)	P
Age [years]	64.4 ± 12.5	61.9 ± 11.5	0.150
Male	70	73	0.370
BMI	26.9 ± 3.9	27.1 ± 4.1	0.827
SBP [mm Hg]	136 ± 28	135 ± 27	0.545
Heart rate, per 1 min	79 ± 17	78 ± 18	0.533
Killip IV at admission	2.9	3.2	0.445
Killip III + IV	4.8	5.7	0.441
Previous MI	14.1	11.6	0.140
History of CRF	2.5	1.9	0.501
History of stroke	2.9	3.9	0.311
Previous PCI	9.3	6.1	0.013*
Previous CABG	1.6	1.2	0.538
Peripheral artery disease	4.0	2.7	0.131
Current smoker	33.6	37.7	0.091
Diabetes mellitus	15.8	15.9	0.950

*p < 0.05; BMI — body mass index; SBP — systolic blood pressure; MI — myocardial infarction; CRF — chronic renal failure; PCI — percutaneous coronary intervention; CABG — coronary artery bypass grafting; unless otherwise stated, data is presented as %

Table 2. Concomitant medications. Angiography and interventional details

	On-hours (n = 645)	Off-hours (n = 1005)	P
Clopidogrel pre-cathlab	32	32	0.980
ASA pre-cathlab	95	94	0.859
Unfractionated heparin pre-cathlab	69.5	67.4	0.690
Thrombolysis pre-cathlab	2.3	4.1	0.041*
IRA in baseline angiography:			
LMCA	1.2	0.6	0.168
LAD	43	45	0.431
Abandoned PCI	8.1	6.1	0.111
Femoral access site	89.1	84.4	0.450
TIMI 2+3 before PCI	26.2	27.4	0.690
Multi-vessel disease	53.5	52	0.565
Stent	85	87.5	0.714
Drug eluting stent	25.6	21.6	0.061
Non-IRA PCI	4.5	4.4	0.910
Thrombectomy	10.5	11.1	0.730
PCI complications:			
No-reflow during PCI	3.6	2.7	0.320
Embolisation	2.3	1.7	0.362
Perforation	0.16	0.10	0.750
Tamponade	0.16	0.10	0.750
Side branch occlusion	0.32	0.80	0.210

*p < 0.05; ASA — acetylsalicylic acid; IRA — infarct-related artery; LMCA — left main coronary artery; LAD — left anterior descending; TIMI — thrombolysis in myocardial infarction; PCI — percutaneous coronary intervention; data are presented as %

Table 3. Timing information

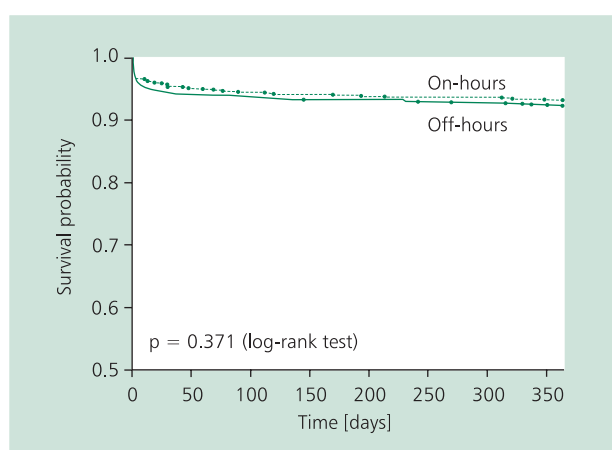
	On-hours	Off-hours	P
Pain-to-diagnosis	183 ± 187	173 ± 210	0.007*
Diagnosis-to-transport	44 ± 47	48 ± 59	0.301
Transport-to-cathlab	40 ± 27	44 ± 29	0.001*
Cathlab-to-balloon	36 ± 27	34 ± 22	0.297
Pain-to-balloon	300 ± 206	298 ± 234	0.206

*p < 0.05; times are expressed in minutes as means and standard deviations

Table 4. Clinical outcomes in-hospital and in long-term follow-up

	On-hours (n = 645)	Off-hours (n = 1005)	P
Death in-hospital:			
Death without Killip 4	3.4	4.3	0.370
Death with Killip 4	2.9	3.4	0.566
Death with Killip 4	21.1	31.6	0.430
Death at 30 days	4.7	5.8	0.320
Death + reMI + urgent revascularisation 30 days	6.9	8.2	0.373
Death at one year	7.6	8.9	0.360
Bleeding complications in-hospital:			
Puncture haematoma	6.2	6.1	0.911
Blood transfusion	1.2	1.9	0.310

*p < 0.05; reMI — repeated myocardial infarction; data are presented as %

**Figure 1.** Kaplan-Meier one-year survival curve for on- and off-hours groups

It has been well established that circadian variation in the time of onset of STEMI, especially during the early hours of the morning, may have an impact on survival. In a small study by Dominguez-Rodriguez et al. [13], the time of onset strongly influenced survival in patients treated with PPCI. In a large retrospective analysis by Magid et al. [14], presentation with STEMI during off-hours was associated with significantly higher adjusted in-hospital mortality (OR 1.07; 95% CI 1.01–

–1.14) and substantially longer times to treatment in the PCI cohort. Kruth et al. [6] who analysed MITRA-PLUS registry data concluded that admission to the catheterisation laboratory during off-hours also resulted in increased in-hospital mortality (Monday–Friday vs night-time vs weekend: 9.4% vs 10.6% vs 11.1%, p = 0.0128 for Monday–Friday vs weekend). However, fewer reperfusion therapies were also applied during weekends and night shifts, which may have influenced the final results of this study. In the most recent paper, Maier et al. [15] reported that patients admitted during off-hours experienced longer delays to PCI and that admission during off-hours remained an independent predictor for in-hospital mortality with an odds ratio of 2.5. What might be the cause of such impaired outcome for STEMI patients during off-hours? Is it just the circadian variation, or do we have to take staff experience and possible fatigue when working outside normal hours into account?

On the other hand, multiple studies have shown no real evidence of worse survival in STEMI patients treated with PPCI during the weekend or at night. Ortolani et al. [9] concluded that the clinical effectiveness of PPCI during off-hours is similar if performed at a centre specifically dedicated to invasive STEMI treatment. Also Slonka et al. [8] believed that a proper organisation of duties in cathlab, a focus on PPCI and thus growing experience provides comparable results of invasive procedures performed in the daytime and off-hours.

In the EUROTRANSFER Registry, both studied groups did not differ in baseline characteristics, although pre-cathlab lysis was more frequently administered during off-hours. This might reflect a strategy of pharmacological reperfusion rather than invasive treatment in some referring centres during off-hours and, that in cases of lack of reperfusion, a decision to send a patient for rescue PCI was being made.

But for the PCI procedure itself performed in the cathlab, off-hours seem to pose no extra hazard of additional complications including bleedings. Bleedings are often an indicator of operators' and staff experience in managing STEMI patients, something which directly influences survival. Therefore, the fact that there was no difference between the study groups in the EUROTRANSFER Registry supports the hypothesis that equal staff experience was ensured round-the-clock. The only advantage also reported in previous studies is the significantly (although with a mean of only 10 min) shorter time from first symptoms onset to the diagnosis of STEMI during the night and weekends. Finally, the EUROTRANSFER Registry reports a fairly low in-hospital mortality during off-hours in comparison to other studies (4.3%). The reason for this might be low patient risk profile, with only 3.2% in cardiogenic shock in comparison to the 9.5% reported by Slonka et al. [8] (with 6.2% in-hospital mortality).

The results of the EUROTRANSFER Registry confirm that PPCI performed during off-hours in experienced high volume centres, oriented at STEMI treatment, results in similar outcomes and safety profiles as PPCI performed during routine hours. It seems that staff skills and experience is the key factor in obtaining comparable results of primary PCI. Focusing on STEMI treatment rather than dispersing team attention might be helpful in achieving regular outcomes, regardless of the time a patient is admitted to the cathlab.

This analysis has a number of limitations, mainly related to the nature of registry studies. The experience of medical staff present at participating centres during off-hours may differ between cathlabs and countries and this could be only partially addressed in our analysis, although all centres which enrolled patients in this registry were 24/7 PPCI highly experienced centres.

CONCLUSIONS

The PPCI performed in high volume, experienced invasive cardiology centres in Europe during off-hours is associated with comparable outcomes and safety profiles as PPCI performed during regular working hours.

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Conflict of interest: none declared

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Pierwotna przezskórna interwencja wieńcowa u chorych z zawałem serca z uniesieniem odcinka ST w godzinach pracy w porównaniu z godzinami nocnymi i w weekendy. Dane z rejestru EUROTRANSFER

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Streszczenie

Wstęp: Pierwotna przezskórna interwencja wieńcowa (PPCI) jest uważana za leczenie z wyboru u chorych z zawałem serca z uniesieniem odcinka ST (STEMI). W wytycznych dotyczących terapii MI podkreśla się wpływ doświadczenia zespołu i ośrodka przeprowadzającego zabieg na rokowanie chorego ze STEMI. Część badaczy uważa, że wykonywanie zabiegów PPCI poza regularnymi godzinami pracy może się wiązać z większym ryzykiem dla chorego.

Cel: Celem pracy była ocena rokowania i częstości występowania powikłań u osób ze STEMI leczonych PPCI w rejestrze EUROTRANSFER w zależności od czasu wykonania zabiegu.

Metody: Zebrano dane dotyczące 1650 pacjentów w 15 ośrodkach w Europie w okresie od listopada 2005 do stycznia 2007 r. Chorych podzielono na tych, u których zabieg wykonano podczas regularnych godzin pracy (*on-hours*), oraz tych, u których PPCI przeprowadzono w trybie dyżurowym nocnym lub w weekend (*off-hours*).

Wyniki: W grupie *on-hours* znalazło się 645 (39%) pacjentów, a w grupie *off-hours* 1005 (61%) osób. Chorzy w obu grupach nie różnili się pod względem czynników demograficznych i ryzyka. Przedszpitalne użycie trombolizy częściej zaobserwowano w grupie *off-hours* (4,1% v. 2,3%; $p = 0,041$). Powikłania zabiegu PPCI występowały równie często w obu badanych grupach. Czas od początku wystąpienia bólu do rozpoznania STEMI był krótszy u chorych z grupy *off-hours* (173 ± 210 v. 183 ± 187 ; $p = 0,007$). Śmiertelność wewnątrzszpitalna wyniosła 3,4% w grupie *on-hours* i 4,3% w grupie *off-hours* ($p = \text{NS}$).

Wnioski: Pierwotna przezskórna interwencja wieńcowa wykonywana w doświadczonym ośrodku kardiologii inwazyjnej wiąże się z podobnym rokowaniem chorego i bezpieczeństwem zabiegu niezależnie od czasu jego wykonania.

Słowa kluczowe: zawał serca, pierwotna angioplastyka wieńcowa, rejestr, dyżur

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