

# Quality of care in primary percutaneous coronary intervention for acute ST-segment - elevation myocardial infarction: Gulf RACE 2 experience

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**BACKGROUND AND OBJECTIVES:** Primary percutaneous coronary intervention (pPCI) has been recognized as an effective management strategy for acute ST-segment-elevation myocardial infarction (STEMI). However, there is no first-hand information regarding the quality of pPCI procedures in the Arabian Gulf countries. This study aims to explore the quality of pPCI practice.

**DESIGN AND SETTINGS:** The Gulf Race II was designed as a prospective, multinational, multicentre registry of acute coronary events, focusing on the epidemiology, management practices, and outcomes of patients with acute coronary syndrome. The study recruited consecutive patients aged 18 years and above from 65 hospitals in 6 adjacent Middle Eastern countries (Bahrain, Saudi Arabia, Qatar, Oman, United Arab Emirates, and Yemen).

**PATIENTS AND METHODS:** We used data from the Gulf Registry of Acute Coronary Events (Gulf RACE 2). We analyzed data on patients who received pPCI to assess the guidelines-supported performance measure of door-to-balloon (D2B)  $\leq$  90 minutes and its impact on morbidity and mortality.

**RESULTS:** Of 3432 patients with STEMI, slightly more than half (53%, n=1832) were admitted to a hospital with a cardiac catheterization laboratory (Cath-Lab). Of these, only 1006 patients (55%) received reperfusion therapy, and pPCI was used in a small predominantly male subgroup (11% of the STEMI cohort admitted to hospitals with Cath-Lab, n=198). The median D2B time in the pPCI cohort was 85 minutes, and a D2B of  $\leq$ 90 minutes was achieved in only 55%. Patients with timely pPCI (D2B  $\leq$  90 minutes) were less likely to have cardiogenic shock and require intra-aortic balloon pump. In-hospital, 1-month and 1-year mortality were not statistically in favor of timely pPCI.

**CONCLUSION:** Primary PCI was underused in the Gulf region with low rate of acute reperfusion and no timely pPCI and thus no mortality benefit.

**S**T-segment-elevation myocardial infarction (STEMI) is a common condition associated with high mortality.<sup>1</sup> However, there has been a considerable decline in mortality as a consequence of improvements in initial therapy, including fibrino-

lysis and primary percutaneous coronary intervention (pPCI). Despite the improvement in overall management (fibrinolysis and pPCI) of STEMI, time is of paramount importance for initiating thrombolysis and performing pPCI in improving survival.<sup>2</sup> The

American College of Cardiology (ACC), American Heart Association (AHA), and the European Society of Cardiology (ESC) recommended that all STEMI patients should undergo rapid evaluation for reperfusion therapy and have reperfusion strategy implemented promptly after contact with the medical system.<sup>3,4</sup>

Based on available data from clinical trials, it is concluded that the state-of-the-art management for patients with STEMI is pPCI and is considered as a preferred method of reperfusion.<sup>5</sup> Several trials have shown that time  $\leq 90$  minutes has been associated with smaller infarct sizes, fewer major adverse cardiovascular events, and better long-term survival.<sup>6-11</sup> International guidelines in the management of patients with STEMI recommended several performance measures to monitor the quality of delivered patient care.<sup>12</sup> Of particular interest are the door-to-balloon (D2B) time (arrival at hospital to pPCI) and overall health care system delay (first medical contact to reperfusion); both of these are acknowledged as valuable performance indicators.<sup>13-16</sup> A previous study in the Arabian Gulf countries, where the prevalence of STEMI is considerably high, showed that about 30% of patients with STEMI arrived at hospital more than 12 hours from the onset of chest pain.<sup>17</sup> In all, pPCI as a preferred reperfusion strategy in STEMI requires optimal systems of care and logistics to enable rapid treatment of all patients. In this study, we aim to explore the quality of pPCI practice and its impact on morbidity and mortality.

## PATIENTS AND METHODS

The Gulf Registry of Acute Coronary Events (Gulf RACE 2) study was conducted between October 2008 and June 2009 in 6 Arabian Gulf countries (Bahrain, Saudi Arabia, Qatar, Oman, UAE, and Yemen). The study protocols were approved by the institutional ethical review boards of all the participating hospitals. Details of the methodology have been previously described.<sup>18</sup> Of the total STEMI patients, we extracted data for analysis from patients who have had pPCI, as indicated in **Figure 1**.

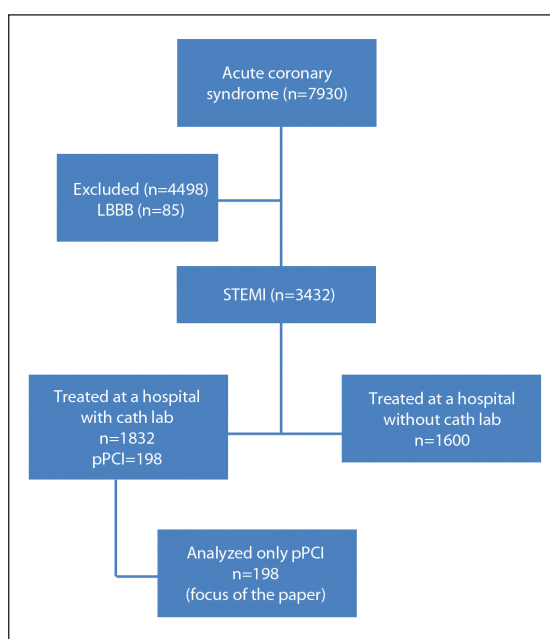
### Statistical analysis

All data were analyzed using SPSS, version 20.0 (SPSS, Inc., Chicago, IL USA). Descriptive summary measures were obtained. Chi-square test or Fischer exact test were used to compare between groups. Multivariate logistic regression analyses were used to identify independent predictors of morbidity and mortality. Statistical significance was set at a 0.05 level.

## RESULTS

Among the 7930 patients with acute coronary syndrome in the GULF RACE 2 registry, 3432 were diagnosed with STEMI (based on electrocardiography [ECG] at presentation). Of these, 1832 were admitted to the surveyed hospitals with cardiac catheterization laboratory facilities. However, only 198 (10.8%) patients received pPCI. These patients had a mean age of 54.0 (11.8) years, were mostly males (87%), and often overweight or obese across all age groups. Our cohort pPCI patients had significant coronary risk factors: 40.8% dyslipidemia, 49.2% diabetes mellitus, 35.5% hypertension, and 54.5% smokers. A significant proportion also had a previous history of coronary artery disease who have had pPCI (12.6%), as shown in **Table 1**.

**Table 2** shows the characteristics of patients who received timely pPCI (D2B  $\leq 90$  minutes) versus delayed pPCI (D2B  $> 90$  minutes). The use of ambulance services was substantially low ( $< 30\%$ ) in both groups, but not significantly lower in delayed pPCI patients (27.7% vs. 16.6%;  $P=.06$ ). Timely pPCI was seen more frequently in the age group between 40 and 59 years. Majority of patients (91%) arrived at hospital within 12 hours from the onset of chest pain. We did not find significant differences between the groups (timely pPCI-D2B  $\leq 90$  minutes versus delayed pPCI-D2B  $> 90$  minutes) pertaining to age, body mass index, comorbid conditions, hospital arrival time (on/off working hours), STEMI type on ECG, and clinical vital signs. **Table 3** shows no signifi-



**Figure 1.** Cohort patients with STEMI and analyzed sample size of pPCI from the Gulf RACE 2 registry.

**Table 1.** The clinical characteristics of patients with STEMI presenting to hospitals with catheterization laboratory, by type of therapy (n=1832).

Variables	No reperfusion (N=826)	Reperfusion (N=1006)		P value
	N (%)	TT (n=808) N (%)	pPCI (n=198) N (%)	
Age (y)	.001			
Less than 30	12.0 (1.5)	12.0 (1.5)	2.0 (1.0)	
30-39	70.0 (8.5)	81.0 (10.1)	15.0 (7.6)	
40-49	215.0 (26.0)	278.0 (34.4)	59.0 (29.8)	
50-59	236.0 (28.6)	263.0 (32.5)	59.0 (29.8)	
60-69	154.0 (18.6)	121.0 (15.0)	37.0 (18.7)	
70-79	88.0 (10.7)	45.0 (5.6)	24.0 (12.1)	
80+	51.0 (6.2)	8.0 (1.0)	2.0 (1.0)	
Gender				
Male	708.0 (85.7)	742 (91.8)	174 (87.9)	.0001
BMI (kg/m <sup>2</sup> )	.052			
<18.5	23.0 (2.8)	15.0 (1.9)	2.0 (1.0)	
Normal 18.5–24.9	306.0 (37.1)	289.0 (35.8)	78.0 (39.6)	
Overweight 25–29.9	341.0 (41.3)	364.0 (45.1)	66.0 (33.5)	
Obese 30–34.9	115.0 (13.9)	112.0 (13.9)	38.0 (19.3)	
Morbid obesity 35–40	26.0 (3.2)	17.0 (2.1)	10.0 (5.1)	
≥40	14.0 (1.7)	10.0 (1.2)	3.0 (1.5)	
WC (cm)	.256			
<88	205.0 (40.6)	145.0 (35.0)	19.0 (31.1)	
88-102	213.0 (42.2)	193.0 (46.6)	33.0 (54.1)	
>102	87.0 (17.2)	76.0 (18.4)	9.0 (14.8)	
Past medical history				
CAD	183.0 (22.5)	161.0 (20.1)	50.0 (25.5)	.204
MI	104.0 (13.0)	77.0 (9.7)	29.0 (14.8)	.044
PCI	31.0 (3.8)	39.0 (4.8)	25.0 (12.6)	.0001
CABG	8.0 (1.0)	6.0 (0.7)	3.0 (1.5)	.592
HF	13.0 (1.6)	11.0 (1.4)	6.0 (3.0)	.256
VHD	5.0 (0.6)	0.0 (0.0)	1.0 (0.5)	.089
Stroke/TIA	42.0 (5.1)	14.0 (1.7)	7.0 (3.5)	.001
CKF	14.0 (1.7)	7.0 (0.9)	2.0 (1.0)	.292
PAD	12.0 (1.5)	6.0 (0.8)	2.0 (1.0)	.365
DM	313.0 (38.7)	243.0 (30.5)	97.0 (49.2)	.000
Hypertension	310.0 (38.0)	259.0 (32.5)	70.0 (35.5)	.073
Hyperlipidemia	145.0 (20.6)	150.0 (24.2)	60.0 (40.8)	.0001
Family history of PCAD	67.0 (9.0)	82.0 (11.5)	32.0 (18.1)	.002

Key: pPCI: primary percutaneous coronary intervention; N: frequency; (%): percentage; TT: thrombolytic therapy; BMI: body mass index; WC: waist circumference; CAD: coronary artery disease; MI: myocardial infarction; PCI: percutaneous coronary intervention; CABG: coronary artery bypass grafting; HF: heart failure; VHD: valvular heart disease; TIA: transient ischemic attack; CKF: chronic kidney failure; PAD: peripheral arterial disease; DM: diabetes mellitus; PCAD: premature coronary artery disease (family history).

cant differences in medication and types of stents used in both groups, except for the loading dose of 600 mg clopidogrel in favor of timely pPCI (68.5% vs. 48.9%;  $P=.02$ ). Table 4 shows that unadjusted cardiogenic shock and Intra-aortic balloon pump (IABP) use were significantly higher in delayed pPCI.

## DISCUSSION

Despite strong recommendations for reperfusion therapy (thrombolysis or pPCI), only 55% of STEMI patients presented to our catheterization laboratory (Cath-Lab) capable hospitals received reperfusion therapy (mainly pharmacological [80%]). Reasons for missing any means of reperfusion have been reported to be multifactorial; in particular, advanced age, comorbid conditions, hypertension, and stroke, as in our cohort of patients. Many strategies to increase the use of appropriate life-saving therapies have been recommended, which include community and physician awareness programs, among other things.<sup>19-22</sup>

Of particular focus, however, is the significant small proportion of 198 (10.8%) STEMI patients who received mechanical reperfusion as pPCI. Although the reasons for these findings were not very clear, the majority of patients were males, often overweight or obese. In addition, patients who received pPCI have had a significant history of myocardial infarction, dyslipidemia, diabetes mellitus, and previous PCI.

Prehospital delays may account for up to 75% of time to treatment delays.<sup>23</sup> The majority of our patients arrived at hospital within 12 hours from the onset of chest pain. The mean and median delay were 4.4 hours and 2.1 hours, respectively; only 37% of them presented within 2 hours of onset of ischemic symptoms, as similar studies have reported.<sup>24-27</sup>

Although it is class 1 recommendation for patients with symptoms suggestive of a possible STEMI to seek medical attention promptly by activating the emergency response system, only 22.7% of our pPCI cohort patients used ambulance. Most patients either drove themselves or had a friend or family member drive them to hospital. The underuse of emergency services was also reported in well-established health care system.<sup>28</sup> It has been shown that direct ambulance transport of STEMI patients to the Cath-Lab can significantly reduce D2B time and subsequently improve the delivery of pPCI and clinical outcomes.<sup>2,29</sup> Such benefits persist regardless of time from the onset of chest pain and baseline risk of mortality.<sup>2,12</sup>

In our study cohort, we found that more patients with timely pPCI were transported by ambulance. Nonetheless, patients with STEMI frequently pres-

**Table 2.** Demographic and clinical characteristics of patients who received timely vs. delayed pPCI.

Variable	Timely pPCI (≤90 min) [N=108]	Delayed pPCI (>90 min) [N=90]	P value
Age (y)			.027
<30	1.0 (0.9)	1.0 (1.1)	
30-39	4.0 (3.7)	11.0 (12.2)	
40-49	36.0 (33.3)	23.0 (25.6)	
50-59	39.0 (36.1)	20.0 (22.2)	
60-69	15.0 (13.9)	22.0 (24.4)	
70-79	13.0 (12.0)	11.0 (12.2)	
80+	0.0 (0.0)	2.0 (2.2)	
Age (mean±SD)	53.4 (10.7)	54.8 (12.9)	.41
Gender			
Male	97.0 (89.8)	77.0 (85.6)	.389
BMI (kg/m <sup>2</sup> )			.718
18.5- 24.9	44.0 (40.7)	36.0 (40.4)	
25-29.9	37.0 (34.3)	29.0 (32.6)	
30+	27.0 (25.0)	24.0 (26.9)	
Clinical history			
DM	48.0 (44.4)	49.0(55.1)	.154
Hypertension	40.0 (37.0)	30.0 (33.7)	.656
History of angina	23.0 (21.7)	27.0 (30)	.193
History of MI	15.0 (14.0)	14.0 (15.7)	.840
History of previous PCI	13.0 (12.0)	12.0 (13.3)	.832
History of CABG	1.0 (0.9)	2.0 (2.2)	.592
History of HF	1.0 (0.9)	5.0 (5.6)	.095
Smoking	63.0 (58.3)	45.0 (50.0)	.255
Mode of arrival to hospital			.063
Ambulance	30.0 (27.7)	15.0 (16.6)	
Private	78.0 (72.2)	75.0 (83.3)	
Time since onset of chest pain			
<12 h	94.0 (90.7)	87.0 (96.6)	.02
<2 h	42.0 (38.8)	32.0 (35.5)	.66
ECG findings			
Anteroseptal	52.0 (48.1)	52.0 (57.8)	.192
Inferior	31.0 (28.7)	23.0 (25.6)	.634
Posteriolateral	25.0 (23.1)	15.0 (16.7)	.289

**Table 2.** (cont.)

Presenting characteristics			
SBP>90 mmHg	105.0 (95.4)	84.0 (93.3)	.551
Killip class I	97.0 (89.8)	75.0 (83.3)	.208
Time of presentation			.669
8:00 AM to 5:00 PM	53.0 (49.1)	41.0 (45.6)	
Off clinic hours	55.0 (50.9)	49 (54.4)	
D2B in min	57 (19)	175 (143)	.0001
Mean (SD)		121	
Median (minimum-maximum)	60 (13-89)	(90-1248)	
All countries	108.0 (54.5)	90.0 (47.2)	.00001
Bahrain	43.0 (76.8)	13.0 (23.2)	
UAE	15.0 (71.4)	6.0 (28.6)	
Qatar	10.0 (62.5)	6.0 (37.5)	
Saudi Arabia	38.0 (40.9)	55.0 (59.1)	
Yemen	2.0 (22.2)	7.0 (77.8)	
Oman	0.0 (0.0)	3.0 (100.0)	

Key: pPCI: Primary percutaneous coronary intervention; N: frequency; BMI: Body mass index; DM: diabetes mellitus; MI: myocardial infarction; CABG: coronary angio bypass grafting; HF: heart failure; ECG: electrocardiogram; SBP: systolic blood pressure; Killip class I: includes individuals with no clinical signs of heart failure; AM: Morning; PM: evening.

ent during off hours (6.00 pm-8.00 am and weekends), and many of our health care facilities were challenged to maintain the availability of pPCI around the clock. This had no effect on patients receiving timely pPCI and hence no effect on outcome. Other studies reported similar findings of pPCI during off hours, partly.<sup>30,31</sup>

We have observed that patients who received timely pPCI were mainly among the age group 40 to 59 years. Comparing the countries, the highest proportion of timely pPCI was achieved in Bahrain (77%), perhaps due to the single-center nature of pPCI program in Bahrain. Such information may be useful for the effective education of particular patient populations and to identify cultural, language, political, and/or financial barriers that may exist to access and/or use care.

Consistent with recent recommendations, there were more use of higher loading dose of 600 mg clopidogrel in all pPCI patients but more significantly in those who received timely pPCI, as this also was shown to contribute to a better outcome.<sup>32</sup>

Regarding in-hospital clinical outcomes, we have noticed that unadjusted cardiogenic shock and IABP use were significantly lower in timely pPCI. However, after adjusting for all patients' covariates, the differences were attenuated and remained weakly significant. There were no significant differences in other morbidity and

**Table 3.** Medications on admission (home), during hospitalization and at discharge from hospital.

Variable	Timely PCI (<90 min) (N=108)	Delayed PCI (> 90 min) (N=90)	P value
First 24 h of admission			
Aspirin	107.0 (99.1)	88.0 (97.8)	.432
Clopidogrel	107.0 (99.1)	88.0 (97.8)	.432
Loading 600 mg	74.0 (68.5)	44.0 (48.9)	.025
Beta-blocker	89.0 (82.4)	73.0 (81.1)	.478
ACEi/ARB	81.0 (75.0)	70.0 (77.8)	.387
Statin	107.0 (99.1)	87.0 (96.7)	.231
Prior to PCI			
Anticoagulation	101.0 (93.5)	79.0 (87.7)	.162
GPIIb/IIIa inhibitor	68.0 (55.7)	.0	.389
Type of stents:			
BMS	57.0 (54.3)	40.0 (50.0)	.738
At discharge:			
Aspirin	103.0 (95.3)	82.0 (91.1)	.260
Clopidogrel	103.0 (95.3)	82.0 (91.1)	.260
Beta-blocker	98.0 (90.7)	76.0 (85.4)	.271
ACEi/ARB	83.0 (76.9)	73.0 (82.0)	.385
Statin	104.0 (96.3)	80.0 (89.9)	.085

Key: ACEi: Angiotensin-converting enzyme inhibitors; ARB: angiotensin receptor blocker; GIIb/IIIa: glycoprotein 2b-3a inhibitor.

mortality components between the groups perhaps due to the small sample size and hospital variability across the participating countries.

Taken all together, the findings highlighted that the majority of hospitals in the Arabian Gulf countries do not meet the required international guidelines on the management of pPCI. Accomplishing a high performance level is an organizational challenge. Recent regional efforts are drawing attention to the importance of D2B time as a key indicator of quality of care for patients with STEMI treated with pPCI. Delays in D2B time have been consistently associated with poorer outcomes in many studies. More importantly, it provides an open, vibrant community for hospitals to share their findings to save lives by reducing the D2B times in hospitals performing pPCI. Thus, a coordinated effort among clinicians, administrators, other health care professionals, emergency units, across all hospitals (within country), may provide a better diag-

**Table 4.** Clinical outcomes, type of reperfusion therapy.

Outcome	Timely PCI (<90 min) [N = 108]	Delayed PCI (>90 min) [N = 90]	P value
In hospital complications			
Recurrent ischemia/ Re-infarction	16.0 (14.8)	9.0 (10.0)	.392
HF	12.0 (11.1)	12.0 (13.3)	.633
Ventilation	6.0 (5.6)	11.0 (12.2)	.095
IABP	4.0 (3.7)	10.0 (11.1)	.043
Inotrope	14.0 (12.9)	17.0 (8.8)	.326
Cardiogenic shock	7.0 (8.5)	15.0 (16.6)	.023
VT/VF	5.0 (4.6)	9.0 (10.0)	.17
Stroke	0.0 (0.0)	2.0 (2.2)	.201
Mortality			
In-hospital	3.0 (2.8)	7.0 (7.8)	.19
1 mo	4.0 (3.7)	8.0 (8.8)	.14
1 y	8.0 (7.4)	14.0 (15.5)	.11

Key: N: Frequency; HF: heart failure; IABP: intra-aortic balloon pump; VT/VF: ventricular tachycardia/ventricular fibrillation.

nosis and treatment approaches for STEMI patients. The provision of pPCI Cath-Lab program, where absent, and intensive training for Cardiac Intensive Care Unit (CICU) physicians, nurses, radiology technicians, and other paramedical staff should be considered as priority to effective reduction in D2B time across the 6 adjacent Gulf countries. Also, improved emergency services and mass patient education programs may improve the use of ambulance services. A particular focus should be given to improving regional awareness in facilitating the adoption of evidence-based practices.

*Limitations*

Our study has several limitations. First, as with most other registries, the study results may not be representative of clinical practice in all hospitals in the region. However, the wide geographic distribution of several hospitals from different health care sectors in our study provides a reasonable overall representation of pPCI care. Second, there is an inherent selection bias because of the observational nature of the study design and the possibility of missing unmeasured important co-variables. Third, the sample size was small in subgroups. Nevertheless, the ongoing Gulf RACE 3 may provide up-to-date data about emergency medical services for acute STEMI patients in the Gulf.

In summary, our data shows that only a small num-



ber of patients with STEMI were treated with pPCI, partly due to the lack of pPCI Cath-Lab program and an ineffective ambulance services use. The D2B time (timely PCI) is suboptimal across almost all participating countries. If patients were treated within an appropriate reperfusion strategy according to their clinical risk, arrival time may have no influence on mortality. There is a pressing need for coordinated efforts among the Gulf countries to achieve improved prehospital and in-hospital patient care to meet international guidelines for pPCI treatment among patients with STEMI.

### Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the research, authorship, or publication of this article.

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