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In-Hospital Outcome of Patients with Cardiogenic Shock Complicating Acute Myocardial Infarction: Results from Royal Hospital Percutaneous Coronary Intervention Registry, Oman

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ABSTRACT

Objectives: Cardiogenic shock (CS) is still the leading cause of in-hospital mortality in patients presenting with acute myocardial infarction (AMI). The aim of this study was to determine the in-hospital mortality and clinical outcome in AMI patients presenting with CS in a tertiary hospital in Oman. ***Methods:*** This retrospective observational study included patients admitted to the cardiology department between January 2013 and December 2014. A purposive sampling technique was used, and 63 AMI patients with CS admitted to (36.5%) or transferred from a regional hospital (63.5%) were selected for the study. ***Results:*** Of 63 patients, 73% (n = 46) were Omani and 27% (n = 17) were expatriates: 79% were male and 21% were female. The mean age of patients was 60±12 years. The highest incidence of CS (30%) was observed in the 51–60 year age group. Diabetes mellitus (43%) and hypertension (40%) were the predominant risk factors. Ninety-two percent of patients had ST-elevation MI, 58.7% patients were thrombolysed, and 8% had non-ST-elevation MI. Three-quarters (75%) of CS patients had severe left ventricular systolic dysfunction (defined as ejection fraction <30%). Coronary angiogram showed single vessel disease in 17%, double vessel disease in 40%, and triple vessel disease in 32% and left main disease in 11%. The majority of the patients (93.6%) underwent percutaneous coronary intervention (PCI), among them 23 (36.5%) underwent primary PCI. In-hospital mortality was 52.4% in this study. ***Conclusions:*** CS in AMI patients presenting to a tertiary hospital in Oman have high in-hospital mortality despite the majority undergoing PCI. Even though the in-hospital mortality is comparable to other studies and registries, there is an urgent need to determine the causes and find any remedies to provide better care for such patients, specifically concentrating on the early transfer of patients from regional hospitals for early PCI.

Cardiogenic shock (CS) remains one of the most serious and challenging conditions in cardiology following acute myocardial infarction (AMI). Its incidence has remained constant for 20 years, and it continues to complicate between 5–8% of ST-elevation myocardial infarction (STEMI) and approximately 2.5% of non-ST-elevation myocardial infarction (NSTEMI) cases.[1–5] Mortality rates in patients with CS continue to be high, and in-hospital mortality approaches 70–80% among those managed medically.[6–11] The landmark trial "Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock (SHOCK)" showed significant improvement in survival from immediate coronary revascularization in patients with CS.[12–14] Since, emergency revascularization, mainly by percutaneous coronary intervention (PCI), but also by coronary artery bypass graft (CABG) if coronary anatomy is suitable, has become established as the preferred treatment for patients with CS. The American College of Cardiology/American Heart Association (ACC/AHA) 2013 guidelines and European Society of Cardiology (ESC) 2012 guidelines recommend emergency revascularization with either PCI or CABG in suitable patients with CS due to pump failure after STEMI irrespective of the time delay from MI onset (Class IB).[15,16]

Despite the interventional advances in cardiology, CS has been reported to cause more than 40% of the in-hospital mortality in different studies of AMI. Currently, there is no published data about CS in

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patients following AMI in Oman, even though there are two tertiary care hospitals with PCI and CABG facilities. The purpose of this study was to determine the in-hospital mortality and clinical outcome in patients presenting with AMI complicated by CS managed in a tertiary care hospital in Oman.

METHODS

This retrospective, observational study was approved by the ethical and research committee of Royal Hospital. It included patients over the age of 18 years who were admitted to the cardiology department between January 2013 to December 2014. A purposive sampling technique was used, and 63 patients with CS complicating AMI who were admitted to or transferred from a regional hospital were selected for the study.

We used the following clinical criteria for CS: systolic blood pressure (SBP) ≤90 mmHg for more than 30 minutes, unresponsive to intravenous fluid administration and requiring inotropic supportive measures to maintain a SBP of ≥90 mmHg, and association with any one of signs of hypoperfusion (cold extremities, impaired mental status, or urine output <30 ml/h, or serum lactate level higher than 2.0 mmol/L) with or without pulmonary congestion.[6] Invasive hemodynamic criteria was not performed. Patients with previous hypotension or shock, transient hypotension, or who required inotropes for a short period were excluded from the analysis. Patients with a severe systemic illness that could decrease short-term life expectancy, evidence of cardiac mechanical complications, and cardiac arrest with resuscitation for more than 30 minutes were excluded from the study.

All relevant data including demographic, clinical, in-hospital treatment, and outcome characteristics of the patients were recorded. Diagnosis of the different types of acute coronary syndrome (ACS) and definitions of data variables were based on the ACC clinical data standards.[17] Left ventricular ejection fraction was classified according to American Society of Echocardiography guidelines: mild left ventricular (LV) systolic dysfunction ejection fraction (EF) 45–55%, moderate LV systolic dysfunction EF 30–45% and severe LV systolic dysfunction EF <30%.[18]

All statistical analyses were performed using SPSS Statistics (SPSS Inc., Chicago, US) version 12.0. Continuous variables were summarized as a mean ± standard deviation (SD). Comparisons between two groups were performed with a *t*-test for continuous variables. Comparisons between two groups were performed with the chi-square test for categorical variables. A *p*-value of <0.050 was considered statistically significant.

RESULTS

A total of 63 patients were included in the study: 50 (79%) patients were male, and 13 (21%) were female. Of these, 46 (73%) were Omani and 17 (27%) were expatriates. Forty (63.5%) patients were transferred from a regional hospital, and 23 (36.5%) patients were admitted via the accident and emergency department. The mean age of the patients was 60.0±12.0 (range = 36–85 years) [Table 1]. CS was found most in patients in their sixth decade of life (30.2%) followed by the eighth (22.2%) and seventh (20.6%) decades.

Table 1: Baseline clinical characteristics of study patients (n = 63).

Variable	Number (%)
Mean age (years±SD)	60.0±12.0
Age range, years	36–85
31–40	3 (4.8)
41–50	12 (19.0)
51–60	19 (30.2)
61–70	13 (20.6)
71–80	14 (22.2)
81–90	2 (3.2)
Transferred patients	40 (63.5)
Admitted patients	23 (36.5)
Sex	
Men	50 (79.4)
Women	13 (21.6)
Risk factors	
Hypertension	25 (39.7)
Diabetes	27 (42.9)
Dyslipidemia	20 (31.7)
Smoking	22 (34.9)
Family history of CAD	1 (1.6)
Prior MI	9 (14.3)
Prior PCI	2 (3.2)
CKD	2 (3.2)
Prior CVA	2 (3.2)
ST-elevation MI	58 (92.1)
Anterior MI	31 (49.2)
Inferior MI	15 (23.8)
Inferior-posterior MI	8 (12.7)
Lateral MI	3 (4.8)
Anterior-inferior MI	1 (1.6)
Non-ST-elevation MI	5 (7.9)

CAD: coronary artery disease; MI: myocardial infarction; PCI: percutaneous coronary intervention; CKD: chronic kidney disease; CVA: cerebrovascular accident.

Table 2: Echocardiographic, angiographic data, and treatment of study patients (n = 63).

Variable	Number (%)
Mild	1 (1.6)
Moderate	15 (23.8)
Severe	47 (74.6)
Thrombolysis	37 (58.7)
Reteplase	22 (34.9)
Tenectaplase	8 (12.7)
Streptokinase	7 (11.1)
Coronary angiogram	62 (98.4)
SVD	11 (17.4)
DVD	25 (39.7)
Triple VD	20 (31.7)
Left main disease	7 (11.1)
PCI	59 (93.6)
Primary PCI	23 (36.5)
Non-primary PCI	36 (57.1)
CABG	3 (4.7)
Medical therapy	1 (1.6)

SVD: Single vessel disease; DVD: double vessel disease; PCI: percutaneous coronary intervention; CABG: coronary artery bypass graft surgery.

Diabetes mellitus and hypertension were the predominant risk factors for CS (42.9% and 39.7%, respectively). Other significant risk factors were dyslipidemia (31.7%), smoking (34.9%), prior MI (14.3%), and prior PCI (3.2%). In our study, 92% of CS patients had sustained STEMI. Of these, anterior wall STEMI was more common (n = 31, 49.2%) followed by inferior wall STEMI (n = 15, 23.8%). Five patients (8%) had NSTEMI. The total revascularization by thrombolysis was 37 (58.7%) and the most common thrombolytic agent used was Reteplase (n = 22, 34.9%). LVEF, evaluated by echocardiography, showed that almost 75% of CS patients had severe LV systolic dysfunction (n = 47; Table 2). Fifty-nine (93.6%) patients underwent PCI, of these 23 (36.5%) patients were taken for primary PCI and 36 (57.1%) had rescue (non-primary) PCI. Three patients were referred for urgent CABG, and one patient died before being taken to the cardiac catheterization laboratory. Only 11 (17.4%) patients had single-vessel disease (SVD), and most had double vessel disease (DVD; n = 25, 39.7%). Left main involvement was present in seven (11.1%) cases.

Table 3: In-hospital outcome of patients (n = 63).

Outcome	Number (%)
Mortality	33 (52.4)
Sepsis	29 (46.0)
Renal failure	28 (44.4)
Dialysis	4 (6.3)
Anemia	3 (4.8)
CVA	2 (3.2)
Peri-procedural MI	1 (1.6)

CVA: cerebro vascular accident; MI: myocardial infarction.

Table 4: Comparison of management procedures and mortality of the study patients (n = 61)*.

Variable	Non-survivor** (n = 31)	Survivor** (n = 30)	*p*-value
IRA-PCI	22 (45.8)	26 (54.2)	0.040
MV-PCI	9 (81.2)	2 (18.8)	
IABP used	10 (62.5)	6 (37.5)	0.348
IABP not used	23 (48.9)	24 (51.1)	
MV used	26 (74.3)	9 (25.7)	0.030
MV not used	7 (25.0)	21 (75.0)	

**Only the 61 patients who survived initial procedure were included for analysis.*
***Data shown as number (%).*
IRA: infarct related artery; PCI: percutaneous coronary intervention; IABP: intra-aortic balloon pump; MV: mechanical ventilation.

In-hospital outcome of the study patients revealed a mortality rate of 52.4% (n = 33). This was followed by sepsis (46.0%) and acute kidney injury (44.4%). Four patients (6.3%) needed renal replacement therapy. Procedure-related complications including cerebrovascular accident (CVA) and peri-procedural MI were less than 5% [Table 3].

Only 61 patients who survived their initial procedure were included for analysis [Table 4]. One patient died before catheterization and another patient died immediately post-CABG. Infarct related artery (IRA)-PCI was done in 48 (78.7%) patients and 11 (18.0%) had more than one vessel PCI. There was a significant survivor benefit observed in IRA-PCI (p = 0.040). An intra-aortic balloon pump (IABP) was used in 16 (26.2%) of cases and did not show any significant mortality benefit. Mechanical ventilation (MV) was used in 35 (57.3%) cases, and there was no statistically significant survivor benefit for use of MV in patients with CS.

DISCUSSION

Our study observed high in-hospital mortality in patients presenting with AMI complicated by CS, despite the majority of patients undergoing PCI.

However, the in-hospital mortality observed (52%) was similar to other studies, which was reported between 40–50%.[1–3,13,19]

The mean age of the study population was 60 years, which was similar to a study from Spain, but lower than studies reported from China (65.1±7.8 years), the United States (69.4±12.7 years), and Germany (70 years).[20–22] The Gulf RACE registry reported that in Oman, ACS patients present a decade earlier than Western patients.[23]

In this study, most patients with CS were male (79.4%) which is comparable to other studies. Fengler et al,[22] reported 30% as female. Babaev et al,[4] reported more than 40% women in their study. This may be because STEMI is more common in men than in women in Middle-Eastern populations. In the Gulf RACE-Oman registry, 33% of men presented with STEMI compared to only 12% of women.[24]

Among the risk factors, diabetes was most prevalent at 43%, which is higher than previous studies (range = 29–35%).[4,20,22] This high prevalence of diabetes among CS patients from Oman is alarming as it is well known that diabetic ACS patients have poor hospital outcomes, and diabetes may contribute to severe LV systolic dysfunction and shock.[25]

The incidence of anterior wall STEMI in this study was nearly 50%. Garcia-Alvarez et al,[20] reported that 68% of their patients had anterior STEMI. This figure was 47% in Thiele et al,[26] study. Infarctions were located anteriorly in most patients (55%) in the SHOCK trial registry.[27] Our results are similar to other populations suggesting that extensive myocardial damage from anterior infarction is the predominant cause for CS.

Thrombolytic therapy was used in almost 59% of patients in this study. Another study reported a similar figure of 69%.[21] This again demonstrates that thrombolysis may not prevent CS. Hence, the primary PCI strategy as mentioned in the ACC/AHA and ESC guidelines should be adopted to prevent CS and mortality.

Our study observed that in-hospital mortality was 52.4% despite the majority of patients undergoing non-primary PCI. Other studies have reported similar mortality rates ranging from 46% to 56%.[19,28–30] The US National Registry of Myocardial Infarction (NRMI) data showed in-hospital mortality of 47.9%.[4] The SHOCK trial demonstrated a steady fall in hospital mortality of CS patients, and a significant survivor benefit for those treated with revascularization at six months. However, this was only if early revascularization was performed promptly (50.3% vs. 63.1%, $p = 0.027$).[12] One predominant reason in this region for high mortality could be non-availability of catheterization laboratories in the district hospitals, and the subsequent delay in transfer of patients to our hospital for intervention. In the United States, Shaefi et al,[30] stratified hospitals according to the number of CS volumes per year and showed that in-hospital mortality decreased from 41% to 37.01% in hospitals with higher CS case volumes. In their study, almost 21% of patients had renal failure, and 11% of patients underwent hemodialysis in a high volume center. However, they did not find a significant incidence of sepsis.

The IABP-SHOCK II trial reported 19% sepsis in their study population.[22] The high sepsis rate (46.0%) in our study is probably related to the high occurrence of systemic inflammatory response syndrome (SIRS). It has been suggested that AMI can cause SIRS and that the inappropriate vasodilation that occurs in SIRS can result in impaired perfusion of the intestinal tract with vascular flow redistribution. This then leads to transmigration of bacteria, and sepsis.[31] SIRS is more common with increased duration of shock. In Oman this is common, with over 60% of patients transferred from another hospital in our study, which meant a long time for intervention.[31]

A study conducted in Spain reported significant LV systolic dysfunction (about 25±10%) in the CS no survivor group. They also found multivessel disease in 25% of cases and left main involvement in 12% cases.[20] The IABP-SHOCK II-trial showed that overall EF was about 25%, and left main involvement was 9%.[23] These findings are similar to our study, wherein the majority of patients had severe LV systolic dysfunction and similar multivessel disease and left main disease, which may have led to high mortality in this study.

In the NRMI registry, of the 340 CS patients enrolled, 163 (47.9%) died. Among the expired CS patients, 74 (33.9%) underwent revascularization by PCI, and 63 (34.1%) patients had primary PCI.[4] In the IABP-SHOCK II trial, 96% of patients underwent PCI and only 1% had emergency CABG. Cardiac mortality was 50%.[22] The high mortality

rate in these two large registries indicates that even if PCI is done in these high-risk CS patients mortality remains high at about 50% which is similar to our analysis.

This study took place in one of the largest tertiary hospitals in Oman, which has PCI facilities and, therefore, usually receives patients in critical condition from regional hospitals. This means that there was a possibility of over estimation of mortality. Our data lacked information on the time from onset of CS to revascularization, which has an effect on mortality. Other variables associated with mortality after PCI, such as ST-segment resolution, myocardial blush grade, thrombolysis in myocardial infarction flow grade, and hemodynamic data were not studied. We had a small number of patients in this study, which may not lead to conclusive results.

CONCLUSIONS

In Oman, patients presenting with AMI complicated by CS have high mortality despite the majority of patients undergoing PCI. Even though in-hospital mortality is comparable to other studies and registries, there is an urgent need to determine the causes and find any remedies to provide better care for these patients. We should concentrate on early transfer of patients from regional hospitals for early percutaneous coronary intervention.

Disclosure
The authors reported no conflict of interests. No funding was received for this study.

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