Predictors of in-hospital mortality in patients with acute myocardial infarction complicated by cardiogenic shock in the contemporary era of primary percutaneous coronary intervention

Primary percutaneous coronary intervention (PPCI) is currently the preferred reperfusion therapy for patients with ST-elevation myocardial infarction (STEMI). About 5–10% of all acute myocardial infarction (AMI) cases are complicated by cardiogenic shock (CS) which is associated with a high in-hospital mortality rate [1–3]. The mortality benefit of early mechanical revascularization has been demonstrated in the landmark SHOCK trial [4] which compared emergency revascularization (PCI or coronary artery bypass grafting) versus a strategy of initial medical stabilization using fibrinolysis and insertion of intra-aortic balloon pump (IABP) in AMI patients with CS. The SHOCK trial, however, was conducted more than a decade ago and there is limited data [5,6] on the clinical outcome of this group of patients in the contemporary era of PPCI.

We therefore sought to evaluate the survival rate and predictors of in-hospital mortality in our cohort of Asian patients with AMI complicated by CS who underwent PPCI at our institution from January 2009 to December 2010. Cardiogenic shock was defined as a systolic blood pressure (SBP) of <90 mm Hg for >30 min or the need for supportive measures to maintain a SBP >90 mm Hg, associated with end-organ hypoperfusion. Clinical data was collected retrospectively on demographic characteristics, presenting signs and symptoms, laboratory investigations, angiographic findings, hospital course and in-hospital mortality. Our study conforms to the ethical guidelines of the 1975 Declaration of Helsinki and was approved by the institution's research committee.

Table 1 shows the baseline clinical characteristics, clinical presentation and angiographic findings of our patients. The mean age at presentation was 63.1 ± 12.1 years with male predominance (88%). The majority of patients (51%) presented with anterior MI with 86% found to have multi-vessel disease on coronary angiography. Diabetes mellitus was present in 50 patients (35%). The mean ejection fraction was 34 ± 12%. 17 patients (12%) presented with out-of-hospital collapse.

Table 2 shows the PCI procedural variables and in-hospital clinical outcomes of our patients. The most common target vessel for PPCI was the left anterior descending artery (44%) followed by the right coronary artery (36%), left main artery (11%) and left circumflex artery (9%). The majority of patients (65%) received bare metal stent implantation during PPCI with post-procedural Thrombolysis in Myocardial Infarction (TIMI) 3 flow achieved in 77% of patients. The median door-to-balloon (D2B) time was 63 ± 30 min. Multi-vessel PCI was performed in 26 patients (18%)

and glycoprotein IIb/IIIa inhibitors were used in 90 patients (62%). For hemodynamic support, 141 patients (97%) received inotropic support and 100 patients (69%) received intra-aortic balloon counterpulsation. 5 patients (3.4%) received extracorporeal membrane oxygenation for refractory shock. The overall in-hospital mortality was 28% (40 patients). 106 patients (73%) developed severe heart failure (New York Heart Association Classes III to IV) with 74 patients requiring mechanical ventilation. 38 patients (26%) developed cardiac arrest during/after PPCI and 32 patients (22%) developed acute kidney injury (AKI; defined as ≥50% increase in serum creatinine in <48 h) during hospitalization.

Factors associated with in-hospital mortality by univariate analysis were older age at presentation, history of cardiac arrest, occlusive left main disease, post procedural TIMI flow, severe heart failure and AKI. By multi-variate analysis, independent predictors of in-hospital mortality were history of cardiac arrest (hazard ratio: 17.5, 95% CI: 4.7–65.2, p = 0.001) and AKI (hazard ratio: 11.1, 95% CI: 2.7–45.5, p = 0.001).

Patients with AMI complicated by CS represent the sickest group of patients in the AMI disease spectrum and posed a great challenge to clinicians worldwide [7]. As mentioned previously, these patients have a high in-hospital mortality rate, ranging from 40 to 74% [1–6]. Previous studies (many performed in the thrombolytic era) including the SHOCK trial/registry have shown that predictors of in-hospital mortality include advanced age, prior MI, left ventricular ejection fraction, severity of mitral regurgitation, left main disease/saphenous vein graft as culprit lesion, extent of coronary artery disease, etc. [8–10]. There is, however, limited data [5,6] on the clinical outcome of this group of patients and its predictors in the contemporary era of PPCI.

PPCI is currently the main reperfusion therapy for STEMI patients in many parts of the world including Singapore. In our study, the overall

Table 1
Baseline clinical characteristics, clinical presentation and angiographic findings.

	N = 145
Mean age, years	63.1 ± 12.1
Male:female, n (%)	127:18 (88:12)
Ever smokers, n (%)	98 (68)
Diabetes, n (%)	50 (35)
Hyperlipidemia, n (%)	63 (43)
Hypertension, n (%)	84 (58)
Previous myocardial infarction, n (%)	15 (10.3)
Previous PCI, n (%)	13 (9.0)
Previous CABG, n (%)	3 (2.1)
LVEF (%)	34 ± 12
Presentation	
Chest pain, n (%)	114 (79)
Out-of-hospital collapse, n (%)	17 (12)
Anterior STEMI, n (%)	74 (51)
Number of obstructed coronary arteries	
1, n (%)	20 (14)
2, n (%)	47 (32)
3, n (%)	78 (54)

PCI = percutaneous coronary intervention; CABG = coronary artery bypass grafting; LVEF = left ventricular ejection fraction; STEMI = ST-elevation myocardial infarction.

Table 2
Percutaneous coronary intervention procedural variables and in-hospital clinical outcomes.

	N = 145
Culprit vessel	
Left main, n (%)	16 (11)
LAD, n (%)	64 (44)
RCA, n (%)	52 (36)
LCx, n (%)	13 (9)
Multi-vessel PCI, n (%)	26 (18.0)
Median D2B time, min	63 ± 30
Bare metal stenting, n (%)	94 (65.0)
Glycoprotein IIb/IIIa inhibitors, n (%)	90 (62)
Inotropic support, n (%)	141 (97)
IABP, n (%)	100 (69)
ECMO, n (%)	5 (3.4)
Post PCI TIMI flow	
TIMI 2, n (%)	23 (15.9)
TIMI 3, n (%)	111 (77.0)
In-hospital clinical outcomes	
All-cause mortality, n (%)	40 (28.0)
Heart failure (NYHA III–IV), n (%)	106 (73)
Cardiac arrest, n (%)	38 (26)
Acute kidney injury, n (%)	32 (22)

LAD = left anterior descending; RCA = right coronary artery; LCx = left circumflex; PCI = percutaneous coronary intervention; D2B = door-to-balloon; IABP = intra-aortic balloon pump; ECMO = extracorporeal membrane oxygenation; TIMI = Thrombolysis in Myocardial Infarction; NYHA = New York Heart Association.

in-hospital mortality for AMI patients with CS was 28%. Several factors were found to be associated with in-hospital mortality i.e. older age at presentation, history of cardiac arrest, occlusive left main disease, post procedural TIMI flow, severe heart failure and AKI. Independent predictors of in-hospital mortality identified in our study were history of cardiac arrest and AKI.

55 patients (38%) in our study had a history of cardiac arrest (including the 17 patients who presented with out-of-hospital collapse) of which 31 patients succumbed. The most common type of cardiac arrest (total number of episodes = 69) was ventricular fibrillation/pulseless ventricular tachycardia (45%) followed by pulseless electrical alternans (35%) and asystole (20%).

The incidence of AKI in our study was 22% and 4 patients require temporary hemodialysis. This is consistent with prior studies which have shown that AKI affects approximately 20–30% of critically-ill patients. The etiology of AKI in AMI patients with CS is likely to be multi-factorial. The management of AKI depends largely on identification and treatment of the underlying cause and also, avoidance of nephrotoxic substances.

Despite achieving a short median D2B time for PPCI, the in-hospital mortality of our patients with AMI and CS remained relatively high. Symptom onset to reperfusion time is an important determinant of mortality in AMI patients, perhaps more so in patients with CS. This parameter warrants further investigation in our group of patients. The results of our study also showed that history of cardiac arrest and AKI

were independent predictors of in-hospital mortality. These two "complications" are potentially preventable. Novel treatment options are certainly needed to improve the adverse prognosis of AMI patients with CS in the contemporary era of PPCI.

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