Original article

Predictors of short-term outcomes in patients undergoing percutaneous coronary intervention in cardiogenic shock complicating STEMI—A tertiary care center experience

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ABSTRACT

Background: Studying the outcomes in patients presenting with cardiogenic shock with ST-segment elevation myocardial infarction (CS-STEMI) and undergoing primary or rescue percutaneous coronary intervention (PCI) may give an insight to the unmet needs in STEMI-care in our region and may help in future recommendations in improving survival.
Materials and methodolgy: During the period from January 2001- June 2017, there were 114 patients included in the study. The demographic, clinical and angiographic characteristics were compared between the survivors and non-survivors. All these variables were also compared between two-time frames (Phase 1- January 2001 to June 2007; Phase 2- July 2007 to June 2017).
Results: Among patients undergoing PCI for STEMI, 7.5% were in cardiogenic shock. In-hospital mortality for the patients included in the study was 53.5%. Total ischemic time (OR = 0.99, 0.99–1; p = 0.02), left ventricular ejection fraction (LVEF) (OR = 0.90, 0.82–0.98; p = 0.02), need for cardio-pulmonary resuscitation (OR = 0.12, 0.24–0.66; p = 0.01), and post PCI TIMI flows (OR = 0.08, 0.02–0.29; p < 0.001) were the significant determinants of in-hospital mortality in the regression analysis. There was no significant change in mortality between the two phases of the study, though there was a reduction in total ischemic and door-to-balloon times, transfer admissions, use of thrombolytics, glycoprotein IIb/IIIa inhibitors, intra-aortic balloon pump, and mechanical ventilation in phase 2.
Conclusion: Patients presenting in CS-STEMI and undergoing PCI continue to experience high mortality rates, despite improvements in total ischemic times. Further improvement in the systems-of-care are required to bring about reduction in mortality in this high-risk subset.

What is already known?

Cardiogenic shock in the setting of STEMI has a very high mortality of nearly 40% even in the developed countries. Early revascularization is the key to reduce mortality rates in this high-risk subset.

What this study adds?

In-hospital mortality in CS-STEMI is 53.5%, despite offering early revascularization and necessary circulatory support to all patients belonging to this subset. These high mortality rates, though have reduced over the years, still continue to be more than 50%. Total ischemic time and post-PCI TIMI flows are the significant predictors of mortality. Improving systems-of-care at our region

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directed towards reduction of total ischemic time may help in further reduction of mortality in this high-risk subset.

1. Introduction

Cardiogenic shock (CS) represents the highest risk subset of ST segment-elevation myocardial infarction (STEMI) with an incidence ranging between 5 and 15%.[1] Prompt invasive management by either primary percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG) has proven to reduce the mortality risk by achieving reperfusion of the ischemic myocardium.[2] Notwithstanding, the mortality rates continue to be as high as 40- 60% despite adoption of early invasive strategy, inotropes/vasopressors, mechanical circulatory support devices, mechanical ventilation and intensive care support.[3] In fact, the real-world data from the Western world which have studied the temporal trends in mortality, have observed a rise in mortality (30.6%) in CS complicating STEMI (CS-STEMI) patients who were managed invasively.[4] There are barely any data on the characteristics of such a high-risk subset at our region.[5] Understanding the treatment characteristics and clinical outcomes in this subset of patients at our center may give valuable insights into the existing practices and unmet needs in our regional systems-of-care for CS-STEMI. Therefore, we proposed to study the clinical, treatment characteristics, angiographic profile and short-term outcomes of patients undergoing PCI for CS-STEMI at our center.

2. Materials and methodology

Consecutive patients with CS-STEMI who underwent primary or rescue PCI between January 2001 and June 2017 were enrolled in the study. This cohort included patients directly admitted to our coronary care unit and those referred from peripheral hospitals without PCI facilities (transfer admissions). The transfer admissions included patients with newly diagnosed STEMI or post-thrombolysis. The diagnosis of STEMI was made if at least two of the following three criteria were met: chest pain; ST-segment elevation of at least 0.1 mV in limb leads or 0.2 mV in precordial leads or a new onset left bundle branch block; elevation of serum creatinine phosphokinase-myocardial band isoenzyme (CPK-MB) above twice the upper limit of normal or elevation of troponin-I assays above 0.01 ng/ml. Cardiogenic shock was defined as a systolic blood pressure (SBP) of 90 mmHg or less despite volume support, or a SBP of 90 mmhg or more needing inotropes or vasopressors or mechanical circulatory support for at least 30 min, along with a congruent clinical presentation. Left ventricular ejection fraction (LVEF) was measured at the time of presentation by an echocardiographer using biplane Simpson's method. Only patients with CS due to predominant left ventricular failure were included in the analysis. Patients with mechanical complications such as severe mitral regurgitation (MR), ventricular septal rupture, free wall rupture with tamponade, isolated right ventricular infarction and CS resulting from excess beta-receptor or calcium channel blockade or as a complication of a cardiac catheterization were excluded. Demographic variables and clinical characteristics at the time of presentation were collected prospectively as part of in-hospital STEMI-registry. From this registry, the data on CS was collected retrospectively.

The strategies of management of STEMI at our center during each of the two phases has been explained in Fig. 1. All the patients with the diagnosis of STEMI underwent an early revascularization strategy either in form of thrombolysis or primary PCI. Thrombolysis was our default revascularization strategy in phase 1, when primary PCI was performed only for CS or for those with contraindications to lysis and rescue PCI for those with failed lysis. Since the start of phase 2, when we were equipped with a 24 × 7 catheterization laboratory, primary PCI has been our default revascularization strategy for all patients of STEMI, rescue PCI was performed for those transfer admissions with failed lysis, and primary PCI after 3 h of lysis as a part of pharmaco-invasive strategy was adopted for transfer admissions with successful lysis. Failed thrombolysis was defined as persisting symptoms or ST segment elevation at 90 min after start of thrombolysis. The time interval from the onset of symptoms to PCI was considered as the
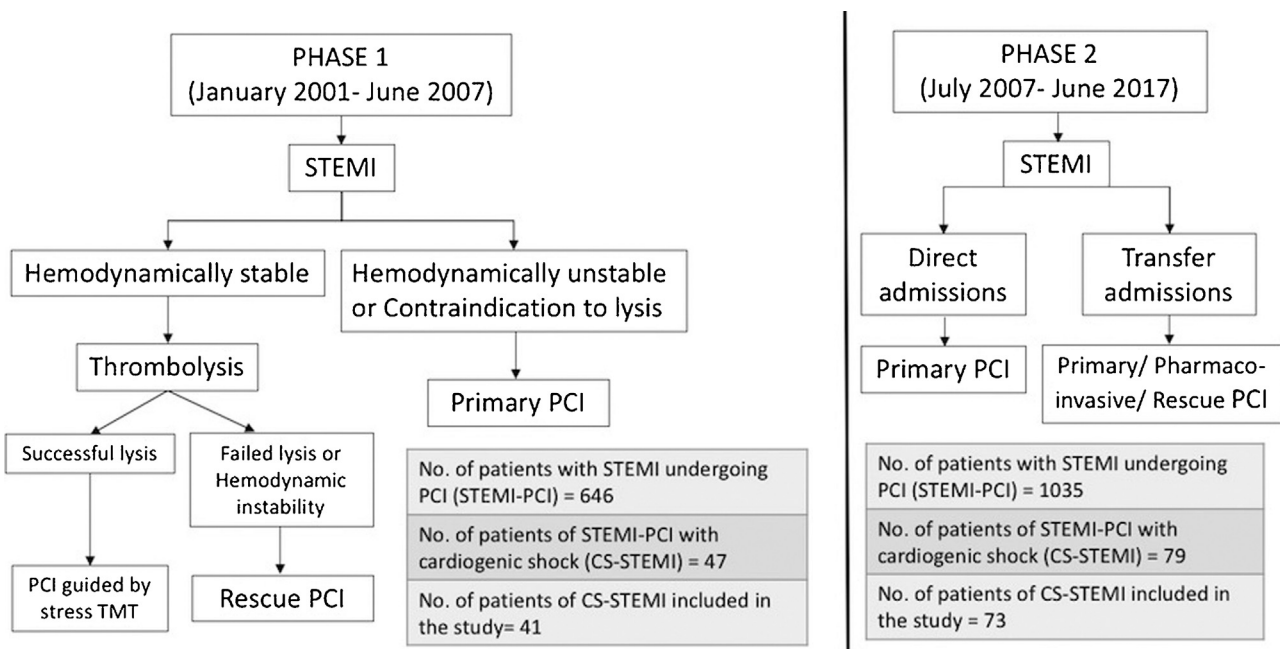

Fig. 1. shows the management strategies for STEMI at our center during the two phases of the study; STEMI- ST-segment elevation myocardial infarction; PCI- percutaneous coronary intervention; TMT- treadmill test; CS- Cardiogenic shock.

total ischemic time. The time interval from the time of activation of the catheterization lab to the PCI was considered as the door-to-balloon time.

In the coronary care unit or during PCI, patients received inotropic/vasopressor support, mechanical ventilation and/or intra-aortic balloon pump (IABP) insertion as clinically indicated. Cardiopulmonary resuscitation (CPR) was administered to patients of cardiac arrest according to the advanced cardiac life support protocol of the institution. Patients were pre-loaded with 325 mg of aspirin and 600 mg of clopidogrel (or 180 mg of ticagrelor). They underwent coronary angiography followed by PCI of all suitable lesions in the infarct-related artery (IRA). Bare metal or drug eluting stents were used according to the operator's discretion. Significant non-culprit lesions were intervened only when there was hemodynamic instability following IRA-PCI.[6] Weight adjusted dose of heparin was administered during procedure. Peri-procedural activated clotting time was maintained > 250 s. Glyco-protein IIb-IIIa (Gp IIb-IIIa) inhibitor was administered as per operator's discretion.

All the coronary angiograms (CAG) were analyzed by a dedicated core laboratory team at our institution who were blinded to the patient profile. The severity of coronary artery disease (CAD) and culprit vessel were determined in the CAG. Coronary flow was defined according to the classification by the Thrombolysis In Myocardial Infarction (TIMI) study group.[7] Occluded vessel was defined as one with TIMI flow 0 or 1 and patent vessel as TIMI flow 2 or 3. Successful PCI was defined as a residual diameter stenosis of <20% and a TIMI 3 flow in the culprit vessel after the procedure. All patients were followed from hospital admission till discharge. In-hospital mortality was defined as those who did not survive in the index hospital admission following the procedure.

The primary objectives of this study were to study the demographic, clinical, treatment and angiographic characteristics of patients with cardiogenic shock due to STEMI undergoing PCI at our center, to compare the characteristics between survivors and non-survivors in the whole cohort, and to study the predictors of mortality. Secondary objective of the study was to analyze the treatment characteristics and mortality outcomes between two different time periods (described as phase 1 and 2). Phase 1 was the period from January 2001 to June 2007 and phase 2 from July 2007 to June 2017. The subgroup division into two-time frames was based on the change in the treatment strategy since the start of phase 2, as explained in Fig. 1. The outcomes of the cohort belonging to phase 1 from the same center has been reported earlier.[8]

3. Statistical analysis

Continuous variables presented in the tables are summarized using descriptive statistics and the categorical data are presented as numbers with percentages. Comparison of variables between the two groups has been done with appropriate tests: Chi-square/ Fisher exact test for categorical variables and student 't' test for means of continuous variables. Total ischemic time and door-to-balloon time have been presented as medians (with 25th and 75th percentiles) and compared between subgroups using Mann-Whitney U test. The variables predicting survival have been studied using a binary logistic regression model. The likelihood of prediction of survival is presented as odds ratio with 95% confidence intervals. All calculated 'p' values are two-tailed and are set at statistical significance of 0.05. All confidence intervals are reported at 95% level. All statistical analyses were performed using SPSS version 22.0 (SPSS Inc, Chicago, Illinois, USA). The study conforms to ethical principles in the Declaration of Helsinki and the study has been approved by the local institutional ethics committee.

4. Results

Overall 1681 patients underwent primary/rescue PCI in the study period and 126 (7.5%) of them were in CS. The incidence of CS in these patients was 7.2% (47 out of 646 patients of STEMI undergoing PCI) in phase 1 and 7.6% (79 out of 1035 patients of STEMI undergoing PCI) in phase 2. The results of phase 1 study have been published earlier.[8] Of these, 114 patients were included for the study and 12 patients with CS secondary to mechanical complications like ventricular septal rupture or free wall rupture or severe MR secondary to papillary muscle dysfunction were excluded from the analysis.

The baseline demographic, clinical and treatment characteristics of those patients of CS-STEMI included in the study (n = 114) are shown in Table 1 and details of angiography are shown in Table 2. Male gender, history of diabetes mellitus and previous myocardial infarction were noted in 83.3%, 50% and 17.5% of patients respectively. The rate of transfer admissions was 44.7%. The median total ischemic time was 6 h and median door-to-balloon time was 60 min. Total ischemic time of ≤3 h was observed in 46.5% of the cases. The mean LVEF was 31.6 ± 7.6%. Rescue PCI after a failed thrombolysis was performed in 11 (16.6%) patients. The need for CPR, IABP insertion and mechanical ventilation was in 27.2%, 71.9% and 37.7% of patients respectively. The coronary angiogram revealed triple vessel disease in 24.6% patients. Left anterior descending (LAD), right coronary artery (RCA) and left main (LM) artery involvement were observed in 65.8%, 21.9% and 2.6% patients respectively. IRA was occluded in 83.3%. Stents were used in 89.5% of the cases, and 63.2% were drug eluting stents. Procedural success was achieved in 57.9% of patients. The in-hospital mortality was 53.5%.

Results of the comparison of all the variables between the survivors and non-survivors are consolidated in Tables 1 and 2. When compared with survivors, non-survivors had a significantly lower mean SBP at presentation (72.1 vs 77.9 mmHg, p = 0.02), lower mean LVEF (30.1% vs 33.4%, p = 0.01) and higher rates of transfer admissions (54.1% vs 34%, p = 0.03), need for CPR (41% vs 11.3%, p < 0.001), use of IABP (83.6% vs 58.5%, p = 0.04), use of inotropes/vasopressors (100% vs 84.9%, p = 0.02). In addition, non-survivors had higher incidence of occluded vessels (91.8% vs 73.6%, p = 0.014) and lower PCI success rate (31.1% vs 88.7%, p < 0.001). However, the demographic variables and distribution of diabetes, hypertension, history of prior myocardial infarction/PCI/CABG and stenting characteristics were comparable between both the groups. Also, the median total ischemic and door-to-balloon times were comparable between both the groups.

Binomial regression analysis of various variables, including the two different phases of the study, are presented in Table 3. The significant predictors of mortality were LVEF, total ischemic time, CPR and post PCI TIMI flows. Poor post PCI TIMI flows (1/0.08 = 12.5 times likelihood of mortality; p < 0.001) had the highest significance followed by need for CPR (1/0.12 = 8.3 times likelihood of mortality).

The results of the sub-group comparison of variables across two-time frames (Phase 1 vs 2) is presented in Table 4. In the phase 2, there was a significant decrease in median total ischemic time (5 vs 12 h, p = 0.003), median door-to-balloon time (50 vs 120 min, p < 0.001), use of thrombolytic agents (5.5 vs 36.6%, p < 0.001), IABP (56.2% vs 100%, p < 0.001), Gp IIb-IIIa inhibitors (56% vs 85%, p = 0.001), need for CPR (17.8% vs 43.9%, p = 0.002), rate of transfer admissions (36.9% vs 58.5%, p = 0.03), use of thrombolytics (5.5% vs 36.6%, p < 0.001) and mechanical ventilation (42.5% vs 70.8%, p < 0.001). There were no significant differences in the mean age, distribution of diabetes, hypertension, use of stents or rate of PCI success between both groups. Importantly, there was no significant difference in rates of post PCI TIMI III flows (63% vs 48.5%, p = 0.1) and in-hospital mortality (52% vs 56%, p = 0.7).

Table 1
Comparison of demographic, clinical and treatment characteristics of survivors and non-survivors of cardiogenic shock due to STEMI undergoing PCI.

Characteristics	All patients (n = 114)	Survivors (n = 53)	Non survivors (n = 61)	p value
Age (years)	59.9 ± 11.0	58.91 ± 11.1	60.7 ± 11.1	0.4
Male (%)	95 (83.3)	44 (83)	51 (83.6)	1
Female (%)	19 (16.7)	9 (17)	10 (16.4)	
Diabetes (%)	57 (50)	22 (41.5)	35 (57.4)	0.1
Hypertension (%)	43 (37.7)	24 (45.3)	19 (31.1)	0.1
Smoking (%)	28 (24.6)	11 (20.8)	17 (27.9)	0.3
Dyslipidemia (%)	15(13.2)	9 (17)	6 (9.8)	0.2
Family history (%)	17 (14.9)	8 (15.1)	9 (14.8)	0.9
Previous MI (%)	20 (17.5)	9 (17)	11 (18)	0.9
Previous PCI (%)	9 (7.9)	5 (9.4)	4 (6.6)	0.5
Previous CABG (%)	2 (1.8)	2 (3.8)	0	0.1
Mean transfer time (hours)	6.7 ± 7.3	7.2 ± 8.8	6.3 ± 5.8	0.5
Transfer admission (%)	51(44.7)	18 (34)	33 (54.1)	0.03
Heart rate (bpm)	101.78 ± 28.9	98.06 ± 27.7	105 ± 29.7	0.2
Creatinine kinase (IU/l)	3066 ± 3158	3069 ± 3065	3064 ± 3262	0.9
Systolic BP (mmhg)	74.8 ± 14.1	77.94 ± 13.0	72.2 ± 14.5	0.02
Median total ischemic time (hours)	6 (3.4, 16)	6 (3, 16.5)	6 (3.5, 15)	0.9
Median door to balloon time (m)	60 (40, 120)	80 (50, 135)	60 (30, 120)	0.2
Total ischemic time ≤ 3 h	53 (46.5)	13 (24.5)	11 (18)	0.5
Total ischemic time < 6 h	64 (56.1)	27 (50.9)	37 (60.6)	0.3
Mean LVEF (%)	31.6 ± 7.6	33.4 ± 7.2	30.1 ± 7.1	0.01
Gp IIb/IIIa inhibitor (%)	76 (66.7)	36 (67.9)	40 (65.6)	0.8
Need for CPR (%)	31 (27.2)	6 (11.3)	25 (41)	<0.001
Use of thrombolytics (%)	19 (16.6)	8 (15)	11 (18)	0.6
Inotropes/vasopressors (%)	106 (93)	45 (84.9)	61 (100)	0.02
IABP (%)	82 (71.9)	31 (58.5)	51 (83.6)	0.04
Mean IABP duration (in hours)	45.0 ± 41.9	58.9 ± 41.4	36.5 ± 40.2	0.02
Mechanical ventilation (%)	43 (37.7)	21 (39.6)	22 (36.1)	0.7
Heparin (%)	103 (90.4)	45 (84.9)	58 (95.1)	0.1
Bivaluridin (%)	11 (9.6)	8 (15.1)	3 (4.9)	
Stent (%)	BMS-30 (26.3)	BMS-15(28.3)	BMS-15(24.6)	0.2
	DES-72 (63.2)	DES-35(66)	DES-37(60.7)	

STEMI- ST segment elevation Myocardial Infarction; PCI- Percutaneous coronary intervention; MI-Myocardial Infarction; CABG- Coronary artery bypass surgery; BP- Blood pressure; LVEF- Left ventricular ejection fraction; CPR- Cardio-pulmonary resuscitation; IABP- Intra aortic balloon pump; BMS- Bare metal stent; DES- Drug eluting stent; all continuous variables are presented as mean± SD with 95% confidence intervals; All categorical variables are presented as numbers (with percentages)

5. Discussion

The main observations of our study are: (i) Incidence of CS in the STEMI patients at our center was 7.5%, (ii) CS-STEMI was associated with a mortality rate of 53.5%, (iii) Post-PCI TIMI flow was the most significant determinant of mortality along with total ischemic time, LVEF and CPR, (iv) Significant reduction in total ischemic time, door-to-balloon time, rate of rescue PCI, use of IABP was observed in the phase 2 as compared to phase 1, however the in-hospital mortality did not show any significant change.

Table 2
Angiographic characteristics of patients of cardiogenic shock due to STEMI undergoing PCI from 2001- 2017.

Characteristics	All PCI patients (n = 114)	Survivors (%) (n = 53)	Non survivors (%) (n = 61)	P Value
Diseased vessels				
SVD (%)	36 (31.6%)	17 (32.1%)	19 (31.1%)	**0.5**
DVD (%)	44 (38.6%)	21 (39.6%)	23 (37.7%)	
TVD (%)	28 (24.6%)	14 (26.4%)	14 (23%)	
LM (%)	6 (5.3%)	1 (1.9%)	5 (8.2)	
Culprit vessel				
LM (%)	3 (2.6%)	0	3 (4.9%)	**0.2**
LAD (%)	75 (65.8%)	32 (60.4%)	43 (70.5%)	
LCX (%)	11 (9.6%)	7 (13.2%)	4 (6.6%)	
RCA (%)	25 (21.9%)	14 (26.4%)	11 (18.3%)	
Pre PCI TIMI flow				
0	68 (59.6%)	25 (47.2%)	43 (70.5%)	**0.01**
1	27 (23.7%)	14 (26.4%)	13 (21.3%)	
2	19 (16.7%)	14 (26.4%)	5 (8.2%)	
3	0	0	0	
Post PCI TIMI flow				
0	4 (3.5%)	0	4 (6.6%)	<**0.001**
1	12 (10.5%)	1 (1.9%)	11 (18%)	
2	32 (28.1%)	5 (9.4%)	27 (44.3%)	
3	66 (57.9%)	47 (88.7%)	19 (31.1%)	
PCI success				
Successful	66 (57.9%)	47 (88.7%)	19 (31.1%)	<**0.001**
Unsuccessful	58 (50.8%)	6 (11.3%)	42 (68.8%)	

PCI- Percutaneous coronary intervention; SVD- Single vessel disease; DVD- Double vessel disease; TVD- Triple vessel disease; LM- Left main; LAD- Left anterior descending; LCX- Left circumflex; RCA- Right coronary artery; All variables are presented as numbers (with percentages)

Table 3
Regression analysis for predictors of mortality in patients with cardiogenic shock due to STEMI undergoing PCI.

	Odds ratio (95% C.I)	p value
Heart rate	1.01 (0.98–1.03)	0.34
Systolic BP	0.97 (0.94–1.01)	0.27
LVEF	0.90 (0.82–0.98)	0.02
Transfer admissions	0.40 (0.13–1.23)	0.11
Total ischemic time	0.99 (0.99–1)	0.02
Total Ischemic time ≤ 3 h	0.47 (0.09–2.34)	0.36
Door-to-balloon time	0.99 (0.99–1.04)	0.6
IABP	0.71 (0.18–2.85)	0.63
Need for CPR	0.12 (0.24–0.66)	0.01
Pre PCI TIMI flows	0.81 (0.35–1.88)	0.63
Post PCI TIMI flows	0.08 (0.02–0.29)	<0.001
Phase 1/2	2.8 (0.58–13.6)	0.19

C.I- Confidence intervals; BP- Blood pressure; LVEF- Left ventricular ejection fraction; IABP- Intra aortic balloon pump; CPR- Cardio-pulmonary resuscitation; PCI- Percutaneous coronary intervention

The incidence of CS-STEMI in our study (7.5%) is comparable to that observed in the Western world (7.9%).[9] In our study, the incidence of CS in STEMI did not differ much between the two phases (7.2% and 7.6% in phase 1 and 2 respectively). In the FAST-MI French registry, the incidence of CS in patients presenting with STEMI or non-STEMI was 6.1%.[10] A much higher incidence (16%) has been reported at a center from northern India.[5]

Cardiogenic Shock has been associated with a very high incidence of in-hospital mortality. In a study comparing patients with and without CS, the all-cause mortality was 39.6% in those with CS-STEMI receiving PCI vs 17.2% in those without CS, during 2007 to 2014.[11] In the Cath PCI registry, analyses of temporal trends and outcomes of patients undergoing PCI for CS-STEMI showed an increase in the in-hospital mortality from 27.6% in 2005–06 to 30.6% in 2011-13.[4] Despite a high rate of early revascularization and use of IABP therapy in the United States, 48% of this subset of patients in 2014 did not survive to discharge.[12] In another study from northern India, the in-hospital mortality rate was very high (66.7%).[5] In our study, the overall mortality rates in the whole cohort of CS-STEMI undergoing PCI was 53.5%, though there was a marginal reduction in mortality during the second phase of the study (56% to 52%).

It is already known that post procedural TIMI flow ≤ 2 is strongly associated with adverse outcome during hospitalization and at 6-month follow-up.[13,14] In our earlier study (Phase 1),[8] as well as in the present study (inclusive of both phases), post PCI TIMI flow was the only consistent and most significant marker of prognosis for in-hospital mortality. Our procedural success rate, comprising of post-PCI TIMI flow of 3, had increased from 48.8% in phase 1 to 63% in phase 2, though this rate is lesser than that observed in the developed world.[9] These differences could be indirectly attributed to the delayed presentation of our patients. Only 56% of our patients in the cohort had total ischemic time < 6 h. In contrast, in the Cath PCI registry more than 75% of such patients presented < 6 h of symptom onset.[4] Total ischemic time was also a significant prognostic marker of mortality in our study, in addition to post procedural TIMI flows, even after adjustment of all confounders.

In contrast to Western world, the time interval between symptom onset to revascularization has been much longer in developing countries like India (CREATE registry).[15] Recently, with the introduction of a structured system-of-care for the management of STEMI at our region, we have observed promising reduction in times to revascularization.[16,17] This trend towards improvement is also reflected in our study with a significant reduction in the median total ischemic and door-to-balloon time in the phase 2. The median total ischemic time of 6 h observed at our center is comparable to 6.8 h observed at another center in our country.[5] In contrast, in a study reporting the critical times to revascularization in the same region using pharmaco-invasive strategy, the median total ischemic time was 185 min in patients of STEMI without cardiogenic shock.[18] This clearly highlights a paradoxical delayed treatment response to these patients of cardiogenic shock. This could be due to therapeutic inertia amongst doctors, thus delaying transfer of sick patients to PCI. Whereas, it is now well known that early revascularization therapy remains the cornerstone of treatment of STEMI particularly in those presenting with CS and PCI remains the key to reduction in mortality in this subset.[19] This was highlighted in the SHOCK trial as well, where the early revascularization arm had lower 30-day mortality rates (46.7% compared to 56% in the medical stabilization arm) and the 6-month mortality rates were significantly lower in the revascularization arm.[1] Thus, our study reveals the need towards achieving shorter total ischemic times by means of early referral to PCI. Improvement in the total ischemic time can not only improve survival but also can translate into better procedural success rates.

Table 4
Comparison of clinical, treatment characteristics and mortality in patients of cardiogenic shock due to STEMI undergoing PCI across two time periods.

Characteristics	Phase 1 2001–2007 (n = 41)	Phase 2 2007–2017 (n = 73)	p value
Incidence of cardiogenic shock	7.2%	7.6%	0.6
Mean age (yrs)	58.2 ± 10.4	60.9 ± 11.3	0.1
Median total ischemic time (h)	12 (5, 26.5)	5 (3.2, 11)	0.003
Median door-to-balloon time (m)	120 (105, 240)	50 (30, 80)	<0.001
Mean systolic BP mm hg	68.8 ± 11.8	78.25 ± 14.2	0.004
Mean LVEF (%)	29.4 ± 7.7	32.9 ± 6.9	<0.001
Diabetes mellitus (%)	53.7	47.9	0.5
Hypertension (%)	36.6	38.3	0.8
Use of thrombolytics (%)	36.6	5.5	<0.001
Multivessel disease (%)	65	67.1	0.2
IABP use (%)	100	56.2	<0.001
Stents use (%)	90.2	89	0.8
Gp IIbIIIa use (%)	85	56	<0.001
Post PCI TIMI III flow (%)	48.8	63	0.1
Need for CPR (%)	43.9	17.8	0.002
Transfer admission (%)	58.5	36.9	0.03
Mechanical ventilation (%)	70.8	42.5	<0.001
In-hospital mortality (%)	56	52	0.7

BP- Blood pressure; LVEF- Left ventricular ejection fraction; IABP- Intra aortic balloon pump; PCI- Percutaneous coronary intervention; CPR- Cardio-pulmonary resuscitation; all continuous variables are presented as mean± SD with 95% confidence intervals; All categorical variables are presented as percentages.

In our study, there was also a reduction in number of patients undergoing rescue PCI (after failed thrombolysis) in the second phase of our study, indirectly meaning a higher adoption of primary PCI as the default revascularization strategy in this high-risk subset. This increase in rates of primary PCI at our center along with improvement in the critical times of STEMI-care, reflects the efforts to get-along-with-the guidelines at our region.[2] However, we did not observe significant difference in the incidence in cardiogenic shock between the two phases and similarly there was also no difference in the procedural outcomes. This might have contributed to similar mortality rates in both the phases of the study.

In the SHOCK trial, 60% of the patients were transferred from centers without PCI facilities. This variable did not influence survival following PCI in the SHOCK study.[1] Similarly, in the present study transfer admission (44.7%) was not a significant predictor of mortality in the regression analysis. This is in contrast to our earlier paper, where we had reported a higher percentage of transfer admissions (58.5%) in the phase 1 significantly contributing to mortality.[8] This reduction in transfer admissions could also contribute to reduction in the total ischemic time and marginal reduction in mortality observed in the phase 2.

Hemodynamic support with IABP, mechanical ventilation and use of Gp IIb-IIIa inhibitors were associated with improved outcomes in CS-STEMI in earlier studies.[20] However, in the landmark IABP-SHOCK II study, the use of IABP did not significantly reduce 30-day mortality in patients with CS-STEMI.[21] In the Cath PCI registry, there was a decrease in the use of IABP from 65% in 2005–06 to 46% in 2011–13.[9] Similarly, our study showed a significant reduction in IABP usage in phase 2 (56.2% vs 100%). In addition, our study also showed decrease in usage of mechanical ventilation and Gp IIb/IIIa inhibitors merely reflecting improved care of patients in ICU and availability of better newer antiplatelet agents.

Our study has a few limitations. This study is an experience from a single tertiary care center and though spanning a period of nearly two decades, involves only a small number of patients. A multi-center data would be more representative of outcomes in the region. While interpreting the small reduction in the mortality rates in phase 2, we have to consider the bias that could have been caused by the decrease in the transfer admission rate from 58.5% during phase 1 to 36.9% in phase 2. In the already published data of phase 1, we had reported no relationship between timing of shock and mortality and therefore this variable has not been considered in this study.[8] Data on the rates of cardiogenic shock according to whether thrombolysis or primary PCI was the treatment option is also lacking. Variables like the bleeding, neurological and renal outcomes have not been studied and could have given more details about the reasons behind the mortality.

6. Conclusion

Our study shows high mortality rates in patients in CS due to STEMI despite offering early revascularization to all the patients. Post-PCI TIMI flows and total ischemic time were the significant predictors of mortality. Though we could observe improvement in the systems-of-care between the two phases of the study, this could not translate into a significant reduction in the in-hospital mortality. Strengthening our systems-of-care by means of reduction of total ischemic time through earlier revascularization may be identified as the unmet need at our region in order to further reduce mortality in this high-risk subset.

Conflicts of interest

All authors declare that there are no conflicts of interest

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