Clinical Investigations

Long-Term Survival and Outcomes after Hospitalization for Acute Myocardial Infarction Complicated by Cardiogenic Shock

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ABSTRACT

Background: Cardiogenic shock is the leading cause of death during hospitalization for acute myocardial infarction (MI). However, little data exist regarding the long-term outcomes of patients who survived the acute phase of MI and were discharged from the hospital.

Methods: We retrospectively reviewed the records of 81 consecutive patients referred for management of acute MI and cardiogenic shock to analyze their in-hospital and long-term outcomes.

Results: Mean systemic systolic and central venous pressures at presentation were 74±15 and 17±7 mm Hg, respectively. Intra-aortic balloon counterpulsation (IABC) was implemented in all patients for a mean of 88±83 hours. Thrombolytics were administered in 49% and mechanical ventilation applied in 46% of patients. Primary angioplasty could not be performed in any patient, while 17 patients later underwent myocardial revascularization during hospitalization. There were 37 in-hospital survivors (45.7%). The 1-year survival after discharge from the hospital was 87.6% in the overall population, versus 100% among patients who underwent in-hospital myocardial revascularization, versus 78.9% among nonrevascularized patients ($p = 0.079$). Over a mean follow-up of 85±47 mo, survival after discharge from the index hospitalization was 44.9% in the overall population, versus 56.2% among revascularized patients, versus 36.4% among nonrevascularized patients ($p = 0.277$). Heart failure developed in 51.6% of patients who were discharged from the hospital.

Conclusions: In this single center analysis, the long-term survival after acute MI complicated by cardiogenic shock was high with nearly 50% of patients surviving free from heart failure.

Introduction

Cardiogenic shock, the leading cause of death of patients presenting with acute myocardial infarction (MI), occurs in 5% to 10% of patients, two-thirds of whom die within a few weeks.[1,2] Recent observations, however, suggest that the introduction of more invasive management strategies in patients with acute MI is decreasing mortality from cardiogenic shock.[3–6] Current practice guidelines recommend the prompt reestablishment of blood flow across the infarct-related artery in the management of shock due to right or left ventricular failure.[7–9] However, most studies of cardiogenic shock have focused on the impact of various treatment modalities on short-term outcomes without examining the long-term prognosis of hospital survivors. The purpose of the present single center study was to evaluate the long-term outcomes of patients who survived the acute phase of cardiogenic shock due to acute MI.

Materials and Methods

Patient and Protocol

The study population consisted of 81 consecutive patients admitted to the intensive care unit of our university hospital between 1990 and 2004 with a diagnosis of MI with ST-segment elevation or new left bundle branch block, complicated by cardiogenic shock. Data were retrospectively collected by review of medical records and electronic database. A diagnosis of cardiogenic shock was made when the systolic blood pressure was <80 mm Hg and urinary output <20 ml/h in presence of mental confusion or peripheral signs of low cardiac output.[10] The decision to administer thrombolytic therapy was left to the on-call cardiologist.

All patients in whom cardiogenic shock persisted for >1 hour after fluid replacement and despite the administration of optimal medical therapy, including diuretics, dobutamine, dopamine or noradrenaline, were placed on

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intra-aortic balloon counterpulsation (IABC). All patients received 50% oxygen via a nasal mask and were placed on completely controlled mechanical ventilation when PaO_2 remained consistently <60 mm Hg. Acute renal failure was defined as anuria lasting ≥24 hours. All new MI, with or without ST-segment elevation, or episodes of unstable angina were classified as recurrent ischemic events. The long-term follow-up information was obtained during ambulatory visits or by telephone contacts. Informed consent was obtained from each patient. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki and was approved by our institution's research committee.

Statistical Analysis

The demographic or clinical characteristics of the two groups of patients were compared with the χ^2 and Student *t* test. Actuarial survivals estimated by the Kaplan-Meier method were compared with the log-rank test. A p value <0.05 was considered significant.

Table 1. Baseline characteristics of 81 patients presenting with acute myocardial infarction and cardiogenic shock

Age, y	63±11
Men/women	57/24 (70/30)
History of coronary artery disease	24 (30)
Previous myocardial infarction	23 (28)
Diabetes mellitus	24 (30)
Smoking history	55 (68)
Arterial hypertension	64 (79)
Hyperlipidemia	24 (30)
Systolic blood pressure, mm Hg	74±15
Heart rate, bpm	104±26
Right atrial pressure, mm Hg	17±7
Pulmonary artery systolic pressure, mm Hg	40±10
Pulmonary capillary wedge pressure, mm Hg	22±10
Pulmonary vascular resistance, Wood units	1.8±1.2
Admission serum creatinine, mg/dl	1.6±0.9
Admission serum creatine kinase, U/L	838±1230
Peak serum creatine kinase, U/L	2891±1774
Time from symptoms onset to thrombolysis, h	3.9±2.9
Time from symptoms onset to diagnosis of shock, h	13.2±12.9

Values are means±SD or numbers (%) of patients. Abbreviations: bpm, beats per minute; SD, standard deviation.

Results

The baseline characteristics of the 81 patients included in this analysis were consistent with profound cardiogenic shock (Table 1). Thrombolytic therapy was administered to 49% of patients. Primary angioplasty could be performed in none of the patients, and percutaneous or surgical revascularization was performed later during hospitalization (delayed revascularization) in 17 patients (21%). Additional information pertaining to the index hospitalization and in-hospital adverse clinical events are shown in Table 2. The baseline characteristics of delayed revascularized and nonrevascularized patients are shown in Table 3.

Of the 81 patients, 37 (46%) were discharged from the hospital alive. Long-term follow-up data were available for 33 patients (89%), who were followed for 85±47 months (range 6–173 months). The 1-year survival rate after discharge from the hospital in these 33 patients was 87.6%. The 1-year survival rate of the patients who underwent myocardial revascularization during the index hospitalization was 100% versus 78.9% for the patients who were not revascularized ($p = 0.079$). In addition, at a mean of 85±47 months after discharge from the hospital, the Kaplan-Meier survival estimates were 44.9% in the overall population (14 deaths; Table 4), 56.2% in patients who underwent myocardial revascularization during the index

Table 2. Characteristics of index hospitalization and in-hospital adverse clinical events in 81 patients presenting with acute myocardial infarction and cardiogenic shock

Duration of intensive care, days (mean±SD)	8.5±6.0
Duration of hospitalization, days (mean±SD)	12.3±9.9
Mechanical ventilation	36 (44)
Duration of mechanical ventilation, h (mean±SD)	74±82
Duration of intra-aortic balloon counterpulsation, h (mean±SD)	88±83
Death	44 (54)
Acute renal failure	24 (30)
Stroke	3 (4)
Vascular complications* and hemorrhages requiring transfusions	15 (18)
Recurrent ischemic events	20 (25)
Type II second-degree or third-degree atrioventricular block	21 (26)
Delayed percutaneous coronary intervention or CABG	17 (21)

Values are means±SD or number (%) of patients. *including limb ischemia. Abbreviations: CABG, coronary artery bypass graft; SD, standard deviation.

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Table 3. Baseline clinical, hemodynamic, and biochemical characteristics in delayed revascularized versus nonrevascularized patients

	Delayed revascularization (n = 17)	No revascularization (n = 64)
Age, y	62±13	64±11
Men/women, % of patients	76/24	70/30
Prior myocardial infarction, % of patients	23	29
Diabetes mellitus, % of patients	35	28
Systolic blood pressure, mm Hg	79±10	73±16
Heart rate, bpm	105±31	104±24
Mean right atrial pressure, mm Hg	17±9	17±7
Pulmonary artery systolic pressure, mm Hg	37.6±10.4	40.7±10
Pulmonary capillary wedge pressure, mm Hg	22.3±10.7	22.3±9.9
Pulmonary vascular resistance, Wood unit	3.0±2.2	1.4±0.8
Serum creatine kinase on admission, U/L	401±647	1132±1768
Peak serum creatine kinase, U/L	2807±1674	2923±1828

All differences between the two groups are statistically nonsignificant. Unless specified otherwise, values are means±SD. Abbreviations: bpm, beats per minute.

Table 4. Long-term outcomes of 33 survivors of the index hospitalization

Chronic heart failure	17 (51)
Acute coronary syndrome	6 (18)
Percutaneous or surgical myocardial revascularization	2 (6.0)
Death	14 (42)
Cause of death	
Noncardiac	4 (12)
Cardiac	10 (30)

Values indicate number (%) of patients.

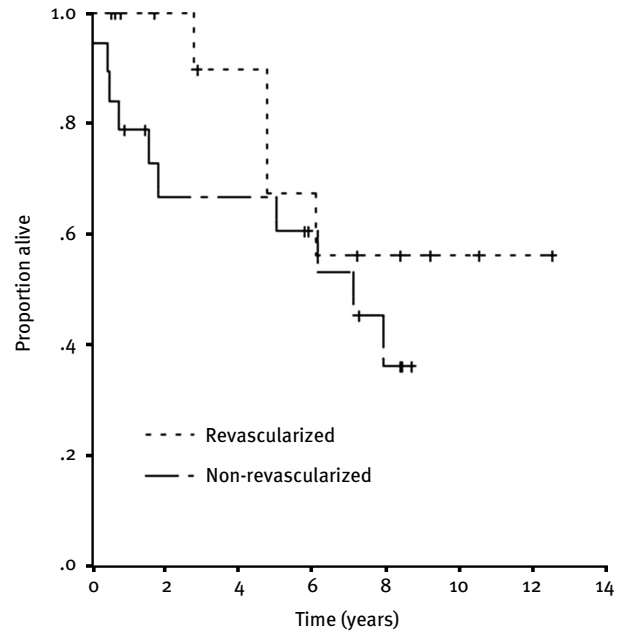

Figure 1. Actuarial survivals according to whether patients did or did not undergo myocardial revascularization during the index hospitalization.

hospitalization, and 36.4% in patients whose myocardium was not revascularized (p = 0.277; Figure 1).

Adverse clinical events recorded during long-term follow-up are shown in Table 4. Approximately 50% of patients discharged from the hospital alive remained free from chronic congestive heart failure, defined as New York Heart Association (NYHA) functional class ≥II (long-term data with regard to heart failure occurrence were available for 32 patients). Adverse cardiac events were the cause of death in 71.4% of patients (Table 4). The baseline characteristics (at hospital admission) of patients who developed chronic heart failure versus those who did not are shown in Table 5.

Discussion

Cardiogenic shock remains the most common cause of death in patients presenting with acute MI. While its incidence in the past 25 y has remained unchanged, mortality associated with cardiogenic shock has decreased in the last 10 y.[11,12] The improvements in short-term outcomes is attributable to the increased use of fibrinolytic therapy, intra-aortic balloon counterpulsation, percutaneous coronary interventions, and coronary artery bypass graft operations.[13,14]

The results of the current study should be interpreted on the basis of the special characteristics of the current study population; all patients with post myocardial infarction cardiogenic shock were supported with intra-aortic balloon counterpulsation, while only 21% of them underwent delayed coronary revascularization. None was treated with primary

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Table 5. Baseline clinical, hemodynamic, and biochemical characteristics of patients who developed chronic heart failure after hospital discharge versus those who did not

	CHF development (n = 17)	No CHF development (n = 15)
Age, y	62±12	60±13
Men/women, % of patients	88/12	77/33
Thrombolysis, % of patients	50	67
Delayed mechanical revascularization, % of patients	47	40
Systolic blood pressure, mm Hg	75±11	74±13
Heart rate, bpm	110±28	90±27
Mean right atrial pressure, mm Hg	13±7	22±9
Pulmonary artery systolic pressure, mm Hg	42±8	34±7
Pulmonary capillary wedge pressure, mm Hg	20±8	22±12
Pulmonary vascular resistance, Wood unit	2.5±1.9	1.6±1.2
Serum creatine kinase on admission, U/L	227±222	1010±1420
Peak serum creatine kinase, U/L	2103±1387*	3838±1837

Unless specified otherwise, values are means±SD. *$p<0.01$ Abbreviations: bpm, beats per minute; CHF, congestive heart failure.

angioplasty, and thrombolysis was administered in 49% of them.

Since most studies of cardiogenic shock have been limited to the impact of various treatment modalities on short-term outcomes, we have focused our investigations on the long-term outcomes of patients after they were discharged from the hospital. We found that these survivors had, on average, a relatively high long-term survival. Furthermore, the patients in our study who underwent revascularization during the index hospitalization tended to have higher long-term survival after their hospital discharge, although the difference did not reach statistical significance, probably due to the small sample size of our study. Our observations are concordant with previously published reports. In Global Utilization of Streptokinase and Tissue Plasminogen Activator for Occluded Coronary Arteries (GUSTO) trial, 88% of 30 d survivors of cardiogenic shock were alive at 1 y.[15] In another study of 200 consecutive patients with cardiogenic shock due to acute MI, the 1-year survival rate after discharge from the hospital was 82%.[16]

With respect to the impact of revascularization, the 1-year post-discharge survival rate was 81% for revascularized patients versus 50% for nonrevascularized patients ($p = 0.006$) in a study of 50 consecutive survivors of cardiogenic shock due to MI.[17] In two other small studies, patients with cardiogenic shock treated with delayed percutaneous coronary interventions during the acute phase of MI had post-discharge 2-year survival rates of 90%–92%.[18,19] Furthermore, in the randomized Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock (SHOCK) trial, the 3 and 6 y survival rates were 78.8% and 62.4%, respectively, among hospital survivors who had undergone early revascularization versus 64.3% and 44.4%, respectively, in patients who were initially stabilized medically.[20] The annual mortality rates of hospital survivors reported by the SHOCK trial were similar to those of age-matched, unselected post-MI patients who underwent primary or delayed percutaneous coronary interventions.[21,22]

Importantly, these favorable post-discharge outcomes were not correlated with the severity of shock at initial presentation. In the SHOCK trial and registry, hemodynamic variables measured near the onset of shock (e.g., cardiac index, stroke work, and systolic blood pressure while receiving support), which are highly predictive at 30 d, did not predict long-term outcomes.[23,24] Furthermore, Singh et al. analyzed data from the GUSTO-1 study and showed that among patients with cardiogenic shock who survived 30 d after myocardial infarction the annual mortality rates of 2% to 4% were similar to those of patients without shock.[25] In addition, percutaneous revascularization during the index hospitalization was associated with a reduced risk of death.[25] Therefore, it seems that, irrespective of the severity of the hemodynamic compromise associated with acute MI, all efforts should be made to stabilize patients and promptly revascularize the myocardium. It should be emphasized that the favorable impact of delayed revascularization on long-term survival found in our study should not be misinterpreted. Primary angioplasty remains the most beneficial treatment approach in the acute phase of post-myocardial infarction cardiogenic shock.

In our study, approximately 70% of deaths during long-term follow-up were attributable to cardiac causes. Two earlier studies (with shorter follow-up observations than ours) reported the mode of death of hospital survivors after MI and cardiogenic shock. In 1 study, 3 of 38 patients died during a median follow-up of 18.1 mo all from cardiac causes.[19] In the other study, 3 of 121 hospital survivors died from cardiac causes up to 1 y of follow-up.[26] Furthermore, in unselected post-MI patients, 50%–60% of deaths during long-term follow-ups have been attributed to cardiac causes.[21,27]

It is noteworthy that, in our study, just over 50% of patients developed chronic congestive heart failure. In other studies with shorter follow-ups, the incidence of functional limitation and chronic heart failure has been variable. In the SHOCK trial, 83% of 1-year survivors reported minimal functional

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limitation (NYHA functional class I or II).[28] Furthermore, in a study of 38 survivors of cardiogenic shock, 13% were in NYHA class ≥II after a median follow-up of 18.1 months.[19]

Limitations

The limitations of this study include those related to a retrospectively performed analysis. Data were obtained by means of chart and electronic database review, which have inherent limitations, such as access and accuracy of the data.

Conclusion

In this single center long-term study, survivors of cardiogenic shock with complicating acute MI had favorable long-term outcomes with nearly 50% surviving without manifestations of heart failure.

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