Hemodynamic Parameters Are Prognostically Important in Cardiogenic Shock But Similar Following Early Revascularization or Initial Medical Stabilization*

A Report From the SHOCK Trial

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Background: **In cardiogenic shock (CS), conclusive data on serial hemodynamic measurements for treatment guidance and prognosis are lacking.**

Methods: **The SHOCK (Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock?) Trial tested early revascularization (ERV) vs initial medical stabilization (IMS) in CS complicating acute myocardial infarction and serially assessed hemodynamics by pulmonary artery catheter.**

Results: **Data were available in 278 patients (95%) surviving to the first measurement with predominant left ventricular failure at baseline and in 174 patients (70%) at follow-up. Baseline and follow-up hemodynamic data were similar in the treatment groups. The median time from CS to baseline measurements was 3.3 h in both treatment groups, whereas follow-up measurements were obtained earlier in the IMS group (median time, 10.6 h) than in the ERV group (median time, 12.5 h; $p = 0.043$). At baseline, stroke volume index (SVI) was an independent predictor of 30-day mortality after adjustment for age (odds ratio, 0.69 per 5 mL/m^2 increase; 95% confidence interval, 0.55 to 0.87; $p = 0.002$). At follow-up, both stroke work index (SWI) [odds ratio, 0.54 per 5 g/m/m^2 increase; 95% confidence interval, 0.39 to 0.76; $p < 0.001$] and SVI (odds ratio, 0.59 per 5 mL/m^2 increase; 95% confidence interval, 0.45 to 0.77; $p < 0.001$) were similarly powerful predictors of 30-day mortality after adjustment for age.**

Conclusions: **SVI and SWI are the most powerful hemodynamic predictors of 30-day mortality in CS patients. Hemodynamic parameters are similar for surviving patients following ERV and IMS. Thus, early hemodynamic stability after IMS should not delay revascularization since long-term outcomes are superior with ERV.** ***(CHEST 2007; 132:1794–1803)***

Key words: cardiogenic shock; catheterization; fatal outcome; myocardial infarction; myocardial revascularization; Swan-Ganz catheter

Abbreviations: CS = cardiogenic shock; ERV = early vascularization; IABC = intraaortic balloon counterpulsation; IMS = initial medical stabilization; IQR = interquartile range; MI = myocardial infarction; PAC = pulmonary artery catheterization; PCWP = pulmonary capillary wedge pressure; SHOCK = Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock?; SVI = stroke volume index; SWI = stroke work index

In cardiogenic shock (CS) complicating myocardial infarction (MI), baseline hemodynamic parameters such as cardiac output, pulmonary capillary wedge pressure (PCWP), cardiac power output, and cardiac power index have been shown to be strong predictors of outcome.[1,2] Similar results have also been shown in a broader spectrum of patients with acute cardiac conditions.[3] It has previously been reported that treatment tailored according to hemodynamic data are associated with lower mortality in CS patients,[4] and hemodynamic profiling and monitoring are thought to be reasonable in contemporary guidelines addressing the care of these patients.[5]

The SHOCK (Should We Emergently Revascularize Occluded Arteries for Cardiogenic Shock?) trial demonstrated that early revascularization (ERV) results in a substantial late survival benefit compared with initial medical stabilization (IMS) for patients presenting with CS due to predominant left ventricular failure[6]; however, there are scant data on the hemodynamic response to early revascularization. Whether ERV is a superior approach in the subset of patients who achieve early hemodynamic stability by receiving medical therapy or whether it should be reserved for those patients who cannot be stabilized medically is unknown. Furthermore, the risk/benefit ratio of further therapy in patients who achieve early hemodynamic stability but are not candidates for revascularization might be of particular relevance given the advent of mechanical circulatory assist devices as an interventional or surgical treatment modality for CS.[7–19]

Accordingly, we sought to determine the prognostic value of baseline and follow-up hemodynamic variables and their change in subjects with CS who were enrolled in the SHOCK trial. Furthermore, we sought to examine whether an interaction exists between the prognostic value of hemodynamic variables and treatment (*ie*, whether certain hemodynamic variables confer a favorable prognosis regardless of whether ERV was performed or not).

Materials and Methods

Study Design and Definitions

This is a predefined subgroup analysis of the SHOCK trial. The trial design has been published previously.[20,21] In brief, patients with CS complicating ST-elevation MI within 36 h and predominant left ventricular failure were randomized to receive an invasive strategy with ERV within 6 h postrandomization or to receive IMS. The study complied with the Declaration of Helsinki and was approved by the institutional review board at each site. All patients gave their informed consent. Study entry required a systolic BP of < 90 mm Hg for 30 min or supportive measures such as vasopressors or intraaortic balloon counterpulsation (IABC) required to maintain a BP of ≥ 90 mm Hg with evidence of decreased organ perfusion (*ie*, urine output of ≤ 30 mL/h or cool and diaphoretic extremities and a heart rate of ≥ 60 beats/min). Hemodynamic CS criteria were PCWP of ≥ 15 mm Hg and a cardiac index of ≤ 2.2 L/min/m^2. In all patients, IABC was strongly recommended. In medically treated patients without contraindications, fibrinolytic therapy was strongly recommended, and revascularization delayed for ≥ 54 h postrandomization was allowed.

Per protocol, hemodynamic parameters were measured serially by indwelling pulmonary artery catheterization (PAC) at four different time points (*ie*, near CS onset, at randomization, 6 h after randomization, and 24 h after randomization). Baseline values were defined as measurements within a time window between 1 h before a recorded diagnosis of CS and 6 h postrandomization using parameters collected near CS onset and at randomization only; the data collected outside this time window were not retained. All baseline values were assessed before onset of the assigned treatment and as close to the onset of CS as possible (*ie*, values closest to CS onset were selected when multiple qualifying measurements were available). Follow-up values were defined as measurements after 3 h postrandomization and up to 24 h postrandomization using prespecified collection times of 6 and 24 h after randomization; data collected outside this time window were not retained. All follow-up values were assessed after the initiation of assigned treatment; for follow-up variables, no data needed to be combined since patients with 24-h measurements did not have 6-h measurements. The following hemodynamic variables were measured directly: heart rate; systolic and diastolic BP; mean PCWP; cardiac index; mean right atrial pressure; right ventricular systolic and diastolic BP; pulmonary artery systolic and diastolic pressure. Mean arterial pressure was estimated using the following formula: (systolic BP − diastolic BP)/3 + diastolic BP. In patients receiving IABC support, the higher BP was recorded as the

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