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Management of Cardiogenic Shock Complicating Acute Myocardial Infarction: The Henry Ford Hospital Experience and Review of the Literature

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Cardiogenic shock complicating acute myocardial infarction (MI) carries a high mortality which in some series prior to 1980 exceeded 80%. Neither the use of inotropic and vasopressor agents nor intraaortic balloon counterpulsation was found to improve survival in this group of patients. Intravenous thrombolytic agents improve survival in patients with acute MI, but their role in cardiogenic shock is unknown. Reports of the use of surgical and mechanical interventions in patients with severe left ventricular dysfunction were examined to determine if there was any benefit to be derived from restoring blood flow to ischemic areas of the myocardium. It was found that urgent placement of intraaortic balloon counterpulsation followed by coronary bypass surgery may improve survival rates and successful coronary angioplasty also appeared to benefit patients with cardiogenic shock. Similar improvement in survival has been reported after successful coronary reperfusion. In surgical series with predominantly nonmechanical causes of shock, survival has varied from 40% to 88%. Data from our five-year experience in the management of MI patients with cardiogenic shock suggest that coronary revascularization with coronary angioplasty or bypass surgery improves survival in patients with cardiogenic shock especially when performed within 24 hours of the onset of shock. (Henry Ford Hosp Med J 1991;39:240-4)

Acutely myocardial infarction (MI) is complicated by shock in up to 15% of patients and carries a high mortality, exceeding 80% (1-6). After the introduction of coronary care units, even though overall mortality decreased in MI, only 19% of patients with shock survived (7).

**Definition**

There is no consistent definition of cardiogenic shock in the literature. Some earlier reports defined shock only on the basis of hypotension (systolic blood pressures below 90 mm Hg), while others insisted on the presence of peripheral circulatory collapse (1-22). Cardiac index and wedge pressures have not been included as part of the definition, even in more recent studies, because not all patients in these studies had Swan-Ganz catheterization performed (23-25). In our study a patient was considered to be in cardiogenic shock when: 1) arterial systolic blood pressure was less than 80 mm Hg without drugs or intraaortic balloon pump support or less than 90 mm Hg with such support; 2) there was no evidence of hypovolemia (pulmonary capillary wedge pressure greater than 12 mm Hg) and cardiac index was low (<2.2 L/min/m²); and 3) the patient demonstrated clinical evidence of hypoperfusion (26).

**Medical Therapy**

Conventional medical therapy does not influence survival in patients with cardiogenic shock (8-22). Although inotropic agents, such as isoproterenol, produce initial improvement of hypotension in some patients with shock, they have not been shown to improve survival. Failure is presumably due to the positive inotropic effect being achieved at the expense of increased myocardial metabolism (12-15). Norepinephrine is considered to be superior to isoproterenol in the treatment of patients with shock because it increases arterial blood pressure by increasing systemic vascular resistance and, unlike isoproterenol, it improves myocardial lactate extraction and coronary perfusion (12,13). Binder et al (11) showed a small improvement in survival with norepinephrine. Similarly, digitalis does not produce any significant change in cardiac output, arterial pressure, or systemic vascular resistance. This lack of hemodynamic benefit may be due to the fact that cardiogenic shock is initiated by the loss of a large amount of myocardium (18). Vasoactive, inotropic agents like dobutamine and dopamine have been utilized for the management of shock, but no benefit in survival has been demonstrated (8,18-20).

Accepted for publication: September 25, 1991.
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Intraaortic Balloon Counterpulsation

In a multicenter trial, Scheidt et al (27) studied the effects of intraaortic balloon counterpulsation in 87 patients with cardiogenic shock and demonstrated hemodynamic improvement. However, survival was not improved. A recent preliminary report by Waksman et al (28) suggested that survival was better in patients treated with balloon counterpulsation. However, in this report coronary revascularization was performed in 67% of patients. Thus, it appears that balloon support combined with revascularization, rather than balloon support alone, improves survival.

Thrombolytic Therapy

Intravenous thrombolytic agents have been shown conclusively to decrease mortality from MI except in patients with severe heart failure. In the latter, mortality was 70% in both streptokinase and placebo groups (29-32). In a study of 44 patients with cardiogenic shock, Kennedy et al (33) reported survival of 58% of patients with successful reperfusion compared to 16% when reperfusion with intracoronary streptokinase was unsuccessful.

Coronary Artery Bypass Surgery

In 1980, DeWood et al (34) demonstrated improved long-term survival in 19 patients treated with urgent coronary bypass surgery. Although this was a small, uncontrolled study, the results suggested that 1) early revascularization salvaged jeopardized myocardium and improved survival, and 2) surgery was feasible and indeed advantageous in a patient population considered to be “too sick for surgery.” In other reports which included patients with predominantly nonmechanical causes of shock, revascularization resulted in rates of survival from 40% to 88% (35-42).

There are several limitations in the surgical data on cardiogenic shock. First, surgical series are subject to considerable selection bias and not all patients with shock undergoing angiography were considered eligible for surgical revascularization. Second, it is difficult to compare various studies since the percentage of patients with surgically correctable mechanical causes, such as ventricular septal rupture or papillary muscle rupture, varies from one study to the other. Third, the definition of shock is not uniform in these studies. Fourth, like the medical series, surgical studies are small and nonrandomized.

Percutaneous Transluminal Coronary Angioplasty

Coronary angioplasty can be performed in acute MI with reperfusion rates from 70% to 90% (43,44). Lee et al (45) studied the effect of coronary angioplasty on survival in 24 patients with cardiogenic shock following acute MI. The 30-day survival was 77% in patients with successful angioplasty versus 18% in those whose angioplasty was unsuccessful. However, in this study none of the patients admitted between 1975 and 1982 were candidates for coronary angioplasty and were therefore treated conventionally. They served as historical controls for patients admitted between 1983 and 1985, all of whom were candidates for coronary angioplasty. Similarly, other studies have reported in-hospital survival of 59% to 71% when shock patients were treated with either primary angioplasty or the combination of successful thrombolysis and bypass surgery (23,24,46).

Henry Ford Hospital Study

The effects of revascularization by coronary angioplasty or bypass surgery on survival were evaluated in 81 patients with cardiogenic shock complicating acute MI admitted from January 1985 to May 1990 (26). Patients with MI in whom shock was secondary to mechanical causes, such as ventricular septal rupture or papillary muscle rupture, were excluded from the study. There were 1,346 patients admitted with confirmed acute MI during this period, of whom 81 (6%) patients with cardiogenic shock form the study population. Successful revascularization was achieved in 32 patients: by angioplasty in 22, bypass surgery in 2, and angioplasty followed by bypass surgery in 8 patients. The nonrevascularized group consisted of 49 patients; 41 had conventional medical therapy and 8 had failed angioplasty.

The clinical characteristics and hemodynamic data obtained at the onset of cardiogenic shock were similar in both groups. Ejection fraction was low in all patients but was a little higher in the revascularized patients (31% versus 25%, P = 0.04).

The overall survival rate was 27% (22 of 81 patients). However, survival was significantly better in revascularized patients (18 [56%] of 32 patients) compared to the nonrevascularized group (4 [8%] of 49 patients) (P < 0.0001). This survival difference persisted at a mean follow-up of 21 ± 15 months, being 50% in the revascularized group versus 2% in the nonrevascularized group (P < 0.0001). The mean time from development of shock to revascularization in survivors was 12.4 ± 15 hours compared to 58.5 ± 93 hours in nonsurvivors (P = 0.004). The most important conclusion was that in-hospital survival was 77% (17 of 22 patients) when revascularization was performed within 24 hours compared to 10% (1 of 10 patients) when revascularization was performed after 24 hours (P = 0.0006).

Even though our institution’s experience is a nonrandomized, prospective observational study, we believe that the groups are comparable. Except for revascularization, no other variable appeared to contribute significantly to survival. These data suggest that coronary revascularization improves survival in cardiogenic shock, especially when it is performed early.

Time From Shock to Revascularization

Just as time from onset of symptoms to administration of a thrombolytic agent in acute MI is critical for survival, a time frame applies to the management of shock by performing revascularization procedures. DeWood et al (34) emphasized that survival was 75% when intraaortic balloon counterpulsation and surgery was performed within 16 hours from the onset of symptoms compared to 29% if this was achieved later. In a report from the Mayo Clinic on 45 patients with cardiogenic shock, the in-hospital survival was 71% with successful angioplasty compared to 29% when the procedure was unsuccessful. Ejection fraction is likely to improve when primary an-
Acute Myocardial Infarction and Clinical Shock

- BP, Organ Hypoperfusion
- Fluids, Inotropes/Vasopressors, Ventilatory Support
- Swan Ganz Catheter, Arterial Line
- Echocardiogram
- Classify Shock
  - Cardiogenic
  - Hypovolemic
  - Other
    - Dehydration
    - Blood Loss
    - Plasma Loss
    - Tamponade
    - P. Embolism
    - Arrhythmias

Fig 1—Suggested management of clinical shock in acute myocardial infarction.

Acute Myocardial Infarction and Cardiogenic Shock

- Non-Mechanical
  - Ventricular Dysfunction
  - Emergency Cardiac Catheterization
  - IABP
  - Early Revascularization, PTCA/CABG
- Mechanical
  - Severe Ventricular Septal Rupture
  - Mitral Regurgitation
  - Emergency Cardiac Catheterization
  - Surgery
  - IABP

Fig 2—Suggested management of cardiogenic shock in acute myocardial infarction.

gioplasty is performed within 4 hours of symptoms in patients with cardiogenic shock (23). Hence, early recognition of cardiogenic shock and prompt intervention are of prime importance.

An outline for the diagnosis and management of patients who develop hypotension during the course of acute MI is shown in Figs 1 and 2.

Hands et al (3) reviewed the Multicenter Investigation of the Limitation of Infarct Size data base and found that enzymatic evidence of infarct extension or reinfarction occurred in 23% of patients in whom cardiogenic shock developed, compared to a 7% incidence among those in whom shock did not develop. The mechanism by which revascularization improves survival remains to be defined, as shock usually occurs several hours to days following actual total occlusion of the infarct artery. Autopsy studies have demonstrated necrosis of greater than 40% of myocardium in patients who develop cardiogenic shock (47). Such patients also show progressive necrosis with infarct extension (48-50). Left ventricular dilatation may occur early and progress over time, leading to hemodynamic deterioration and sometimes rupture (51-60). There is experimental evidence that late reperfusion inhibits infarct expansion (60). It is possible that revascularization in human cardiogenic shock may be beneficial by preventing or limiting infarct extension and expansion and left ventricular dilatation.

Predictors of shock include history of previous infarction, diabetes, age greater than 65 years, admission radionuclide ejection fraction less than 35%, and a peak creatine kinase MB determination greater than 160 IU/L (3). We propose that in the clinical setting of acute MI, these predictors should be carefully evaluated and patients with these factors be closely monitored for hemodynamic deterioration. If deterioration develops, they should be considered for emergency revascularization by percutaneous transluminal coronary angioplasty and/or coronary artery bypass graft surgery.

References


