

Cardiogenic shock in myocardial infarction-results of in-hospital follow-up

Research Article

Damian Kawecki*, Beata Morawiec, Renata Rybczyk, Zofia Trzepaczyńska, Brygida Przywara-Chowaniec, Celina Wojciechowska, Marcin Fudal, Przemysław Wilczewski, Wojciech Jacheć, Ewa Nowalany-Kozielska

*2nd Department of Cardiology, Zabrze,
Silesian Medical University of Katowice,
Zabrze 41-800, Poland*

Received 8 September 2010; Accepted 8 November 2010

Abstract: The purpose of this study was to present the outcomes of treatment of cardiogenic shock (CS) complicating acute myocardial infarction (AMI) among patients hospitalized from 1999 through 2006. The study enrolled 1003 patients. Group 1 comprised 87 patients presenting with AMI complicated with CS, whereas Group 2 comprised 916 patients presenting with AMI without CS symptoms. Determination of invasive treatment was according to standard guidelines. The endpoint comprised death, stroke, and reocclusion/reinfarction. Follow-up was confined to the intra-hospital period. CS was observed more frequently in cases of ST-elevation MI (STEMI) and right ventricular MI. The transportation and door-to-needle time were shorter in Group 1. CS patients were characterized by a more severe coronary artery disease, higher maximal creatinine kinase levels, lower global ejection fractions, and increased incidence of atrioventricular conduction disorders. The efficacy of percutaneous coronary intervention (PCI) was 82.26% in Group 1 and 95.03% in Group 2. Death occurred in 33.3% of CS patients and in 3.6% of AMI patients ($p < 0.0001$). Our study proved that in a short-term follow-up, PCI is a procedure of high efficacy in CS patients. The short-term follow-up precluded a conclusion of statistically significant benefits from the shortening of the transportation and door-to-needle time.

Keywords: Myocardial Infarction • Shock • Myocardial Revascularization • Angioplasty

© Versita Sp. z o.o.

1. Introduction

Cardiogenic shock (CS) is one of the most dangerous and often fatal complications of acute myocardial infarction (AMI). Despite all of the advanced available treatment options, which include early revascularization, intra-aortic balloon pump (IABP), mechanical ventilatory support, recent pharmacotherapy and their combinations, CS remains the most common causes of death among patients who present with AMI.

The main source of information about the risk of developing CS and its treatment, implications and outcome, is the SHOCK Trial Registry [1]. This trial proved that early revascularization was beneficial only after 30 days of follow-up, whereas shorter periods of observation did not reveal any significant benefits from such treatment.

The SHOCK Trial indicated that left ventricular

failure was the main cause of CS. Other factors, such as right ventricle dysfunction or muscle rupture, were less significant. The SHOCK trial also indicated that the majority of patients develop CS after admission to the hospital [2,3]. The authors focused on the door-to-needle time and the need for its maximal reduction. Patients with developing CS should be immediately transferred to the catheter lab without being seen in the emergency department.

The purpose of this study was to present the experience and outcomes of treatment of CS that complicated AMI during in-hospital observation.

* E-mail: d.kawecki@interia.pl

2. Material and Methods

2.1. Patient inclusion criteria

This is a retrospective study that enrolled 1003 consecutive patients who presented with AMI and were hospitalised from 1999 through 2006 in the 2nd Department of Cardiology in Zabrze, Poland. AMI was diagnosed according to the AMI diagnosis criteria [4]. The diagnosis of right ventricular MI was determined from electrocardiograms (ECG) and defined as follows: an ST-segment elevation of ≥ 0.1 mV in the right precordial leads, echocardiographical evidence and clinical presence of hypotension and/or jugular venous pulse using the right ventricle ECG-leads. CS was diagnosed when the following clinical and haemodynamic criteria were present: cool, wet skin; reduced urine output; systolic blood pressure (SBP) lower than 90 mmHg or a 30 mmHg decrease in SBP that lasts for at least 30 minutes; and patients with SBP between 90 mmHg and 110 mmHg who were being treated with an IABP or inotropic agents. All cases of CS were diagnosed at the emergency department. All the patients underwent basic laboratory tests, electrocardiography upon admission, and echocardiography during the hospitalization.

2.2. The protocol

PCI was performed in patients who satisfied the European Heart Association criteria for the diagnosis and treatment of AMI. Coronary angiogram was mainly performed using the femoral approach (Seldinger technique) with subsequent immediate primary PCI of the infarct related artery (IRA). Patients who were disqualified from PCI and considered suitable candidates for surgical treatment underwent urgent coronary artery bypass grafting (CABG). Medical stratification was applied to patients who were disqualified from PCI and CABG. The definition of procedural PCI success was a thrombolysis in myocardial infarction (TIMI) flow grade 3 in the treated vessel and a final residual stenosis of $<30\%$, as well as no dissection and the absence of clinical end points. Depending on the indications and doctor's discretion, the medical stratification comprised antiplatelet agents (acetylsalicylic acid, clopidogrel, ticlopidine, abciximab, eptifibatide), antithrombotic agents, analgesics (morphine), beta-blockers, ACE inhibitors, aldosterone antagonists and inotropic agents (dopamine, dobutamine, norepinephrine, epinephrine). Nitrates and diuretics were administered according to the symptoms presented by the patients. In all patients, myocardial necrosis markers were monitored, and ECG was performed to analyze dangerous rhythms (atrio-ventricular conduction

Table 1. Baseline characteristics.

	GROUP 1 (N=87)	GROUP 2 (N=916)	P
Sex n (%):			
- male	58 (66.7)	645 (70.4)	ns
- female	29 (33.3)	271 (29.6)	ns
Age (years $\pm$ SD)	61.5 $\pm$ 11.5	61.3 $\pm$ 11.3	ns
Hypertension n (%)	33 (37.9)	533 (58.2)	<0.0001
Diabetes n (%)	16 (18.4)	194 (21.2)	ns
Dyslipidemia n (%)	23 (26.4)	323 (35.3)	0.0439
Family history n (%)	21 (24.1)	314 (34.3)	0.0230
Smoking n (%)	48 (55.2)	532 (58.1)	ns
History of AMI n (%)	19 (21.8)	122 (17.4)	ns
History of PCI n (%)	26 (8.7)	151 (16.5)	ns
History of CABG n (%)	11 (12.6)	85 (9.3)	ns

AMI – acute myocardial infarction; CABG – coronary artery bypass grafting; PCI – Percutaneous coronary intervention

disorders - II° or III° block, ventricular tachycardia, ventricular fibrillation). Left ventricular function was evaluated by echocardiography.

The clinical end-point comprised death, stroke, and reocclusion/reinfarction.

2.3. Statistical Methods and Experimental Procedures

Obtained data are presented as the mean, standard deviation, median and 1st and 3rd quartile. Before statistical comparison of the two study groups, the normality of the distribution was assessed. For further analysis, Mann-Whitney and Wilcoxon's matched-pair tests were used. Qualitative data were statistically evaluated with two fraction and χ^2 with Yates correction tests.

3. Results

A total of 1003 patients who suffered from myocardial infarction were enrolled in the study from 1999 through 2006. The study group (Group 1) comprised 87 patients who presented with AMI complicated with CS, whereas the control group (Group 2) comprised 916 patients who presented with AMI without CS symptoms. Baseline characteristics are presented in Table 1. Patients in Group 1 had lower rates of hypertension ($p<0.0001$), dyslipidemia ($p=0.0439$) and were less likely to have a positive family history of cardiovascular diseases ($p=0.0230$) in comparison with patients in Group 2. The clinical data upon admission are presented in Table 2. Cardiogenic shock patients were characterised by lower SBP and DBP ($p<0.0001$), higher heart rate ($p<0.0001$)

Table 2. Clinical characteristics at the moment of admission.

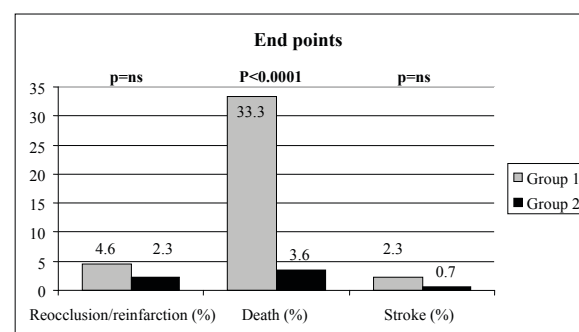
	GROUP 1 (N=87)	GROUP 2 (N=916)	P
Blood pressure (mmHg±SD):			
- systolic	83.5±15.7	134.1±22.1	<0.0001
- diastolic	57.5±12.0	82.3±12.5	<0.0001
Heart rate n±SD	91.95±31.6	77.83±14.93	<0.0001
STEMI n (%)	78 (89.7)	668 (72.9)	<0.0001
NSTEMI n (%)	9 (10.3)	248 (27.1)	<0.0001
Right ventricular MI n (%)	11 (12.6)	19 (2.1)	<0.0001
MI location:			
- anterior wall n (%)	39 (44.8)	358 (39.1)	ns
- infero-lateral wall n (%)	48 (55.2)	558 (60.9)	ns

MI – myocardial infarction; NSTEMI – non-ST-elevation myocardial infarction STEMI – ST-elevation myocardial infarction

and were more frequently diagnosed with STEMI and right ventricular infarctions ($p<0.0001$ and $p<0.0001$, respectively). Anterior and infero-lateral AMI location was not favourably associated with cardiogenic shock. Urgent coronary angiography was performed in 75 patients from Group 1 and 888 from Group 2. Accordingly, 12 and 28 patients, from Group 1 and Group 2, respectively, did not undergo angiography because they either died before reaching the emergency department, refused invasive treatment, or underwent successful initial medical stabilization. The results of the coronary angiography, time from the onset of the infarct pain to the reperfusion of IRA, and the treatment characteristics are displayed in Table 3. Patients with CS symptoms suffered from one-vessel disease less frequently than those without (26.6% vs. 39.5% of AMI patients, $p=0.008$). The transportation time and door-to-needle time in STEMI were shorter in Group 1 ($p=0.0003$ and $p=0.0048$, respectively). Primary PCI was performed with equal frequency in both groups; however, coronary stents were implanted more frequently in Group 2 ($p=0.0031$). PCI efficacy in IRA was also higher in Group 2 patients (95.03% in Group 2 vs. 82.26% in Group 1, $p=0.0029$). Inotropic agents were more frequently administered to CS patients.

CS patients were characterised by higher maximal creatinine kinase levels ($p<0.0001$), lower global ejection fractions ($p=0.003$), as well as increased incidence of atrio-ventricular conduction disorders ($p<0.0001$), bradycardia ($p=0.0017$) and temporary pacing ($p<0.0001$). Shock patients required mechanical ventilation more frequently than Group 2 patients ($p<0.0001$) (Table 4). The observation time was shorter in Group 1 than in Group 2 (8.25 ± 7.07 days and 9.19 ± 5.34 days, respectively, $p=0.0306$).

During the in-hospital follow-up, there was a higher mortality of patients who were admitted with

Figure 1. Clinical endpoints.

CS symptoms ($p<0.0001$). There was no statistically significant difference between groups in the incidence of stroke and reocclusion/reinfarction ($p=ns$) (Figure 1).

4. Discussion

Cardiogenic shock occurs when the infarction involves at least 40% of the left ventricular tissue [5]. Thrombolytic therapy did not reduce mortality in patients with CS following MI [6]; the GISSI trial [7] compared the mortality rates of patients who were treated with streptokinase (69.9%) versus placebo (70.1%). Recent studies have defined a wide range of factors that promote the development of CS; these include advanced age, female gender, significant past medical history of MI, diabetes, and heart failure symptoms that precede MI [8]. Our data is not consistent with these findings. Although in both groups, a high percentage of patients had a history of coronary disease (AMI, PCI, CABG), patients who developed CS had an apparently better risk-profile. They were less frequently diagnosed with dyslipidemia and hypertension and were less likely to have positive family history of cardiovascular diseases. This may be because they were less aware of their health and postponed clinical evaluation. However, patients in Group 2, who were more frequently diagnosed with dyslipidemia and hypertension, had better clinical outcomes and did not develop CS. This could be explained by previous chronic drug treatment for those diseases and increased self-awareness in these the patients that enabled them to recognize the symptoms early and call the ambulance.

Lower ejection fraction (EF) in Group 1 could be correlated with higher incidence of endpoints in this group. Previous studies that report similar ejection fraction among patients who presented CS in MI, also indicate EF as a probable factor for the higher incidence of clinical endpoints [3,9,10].

Numerous randomized trials, conducted on patients who presented with AMI, reported that urgent coronary

Table 3. Angiographic characteristics.

Angiographic parameters	GROUP 1 (N=87*)	GROUP 2 (N=916)	P
Time of chest pain (hours±SD):			
- STEMI	7.33±13.51	7.68±12.63	ns
- NSTEMI	9.29±8.24	11.96±13.63	ns
Transportation time (min±SD):	24.77±20.15	30.73±20.68	0.0003
Door-to-needle time (min±SD):			
- STEMI	30.15±20.79	39.52±41.57	0.0048
- NSTEMI	108.3±186.8	120.8±150.8	ns
Needle-to-optimal result time(min±SD):			
- STEMI	35.39±29.04	35.55±23.97	ns
- NSTEMI	58.29±59.42	74.17±72.97	ns
Coronary artery disease n (%):			
- one-vessel	20 (26.6)	350 (39.5)	0.0080
- two-vessel	20 (26.6)	255 (28.7)	ns
- three-vessel	34 (44.2)	274 (30.8)	0.0098
- no changes	1 (1.5)	9 (1.0)	ns
Infarct-related artery n (%):			
- LM	4 (4.6)	11 (1.2)	ns
- LAD	27 (31.0)	320 (34.93)	ns
- Cx	12 (13.8)	194 (21.18)	ns
- RCA	30 (34.5)	322 (35.15)	ns
- IRA not found/no angiogram	2/12 (16.1)	41/28 (7.54)	ns
Primary PCI n (%)	62 (82.66)	744 (83.78)	ns
Stent n (%)	48 (77.42)	641 (86.16)	0.0031
IABP n (%)	7 (8.0)	0 (0)	ns
Inotropic agents	45 (52)	55 (6)	<0.0001
GP mIib/Illa receptor inhibitors	17 (19.5)	152 (16.6)	ns
Final TIMI 3 in IRA n (%)	51 (82.26)	707 (95.03)	0.0029
CABG (immediate):	1 (1.15)	35 (3.82)	ns
CABG (urgent):	5 (5.75)	70 (7.64)	ns

* Urgent coronary angiography was performed in 75 patients from Group 1.

CABG – coronary artery bypass grafting; Cx – Circumflex artery; IABP – intra-aortic balloon pump; IRA – infarct related artery; LAD – left anterior descending artery; LM – left main; NSTEMI – non-ST-elevation myocardial infarction; PCI – Percutaneous coronary intervention; RCA – right coronary artery; STEMI – ST-elevation myocardial infarction.

Table 4. Clinical characteristics.

	GROUP 1 (N=87)	GROUP 2 (N=916)	P
CPK max level [IU/L] n±SD	3344.4±4135.0	1591±1670.1	<0.0001
EF (%±SD)	37.6±13.9	43.9±10.3	0.0003
Atrial fibrillation n (%)	2 (2.3)	26 (2.8)	ns
A-V conduction disturbances n (%)	14 (16.1)	33 (3.6)	<0.0001
Ventricular fibrillation n (%)	3 (3.4)	12 (1.3)	ns
Ventricular tachycardia n (%)	2 (2.3)	9 (1.0)	ns
Bradycardia n (%)	11 (12.6)	36 (3.9)	0.0017
Temporary pacing n (%)	15 (17.2)	35(3.8)	<0.0001
Intubation n (%)	27 (31.0)	6 (6.6)	<0.0001
IABP n (%)	7 (8.0)	0 (0)	ns
Observation time (days±SD)	8.25±7.07	9.19±5.34	0.0306

A-V – atrio-ventricular; CPK – creatinine kinase ; EF – ejection fraction; IABP – intra-aortic balloon pump.

revascularisation of IRA protects the heart muscle from the spread of ischemic damage, protects left ventricle systolic function and improves short- and long-term survival. The efficacy of PCI in CS was 83% [11]. TIMI flow grade 3 was achieved in 71% of patients in the SHOCK Trial Registry, and the efficacy of our procedures was 82.26%. Despite short transportation and door-to-needle time, which averaged 55 minutes, the duration of chest pain observed in the present study is long. Ortolani *et al.* suggest that it is possible to reduce the mortality of CS patients by direct referral to PCI avoiding the local hospital and emergency department. Reduction in the interventional treatment delay to less than 2 hours is of huge value and might provide survival benefits [12].

The SHOCK Trial also demonstrated a remarkable improvement in outcomes for patients with CS who underwent rapid revascularisation. However, such results have been shown only after 30 days of observation and did not apply to short-term follow-up. Our analysis was conducted during in-hospital stays with a mean observation time of 8.25 ± 7.07 days for CS patients. The observational period in CS patients is shorter than in AMI patients. This may be explained by a higher mortality rate among CS patients that significantly shortened the observation time.

The low rate of the administration of IIb/IIIa inhibitor in CS patients (19.5%) was determined by the technical and financial status of our department. Since 2003, glycoprotein IIb/IIIa inhibitors have been in common use and were administered to 30% of the CS patients.

Mechanical cardiac assist devices enhanced hemodynamic stabilization [13,14] and enabled more percutaneous interventions that resulted in a marked improvement in the survival of CS patients. Only 7 of our patients (8%) underwent IABP. The use of IABP was low because our emergency unit was not equipped with IABP until 2005. Since that time, IABP has been used in 78% of CS patients. Those 7 patients, in which IABP was used, are not adequate for defining the influence of IABP on the intra-hospital period.

The revascularization of coronary arteries comprises percutaneous interventions and cardiac surgery. Surgery is the treatment of choice in mechanical complications of AMI. It is also a standard method of treatment for multi-vessel CAD. In the SHOCK Trial, 27.9% of 136 patients, who underwent cardiac surgery procedures, died during the in-hospital stay. We performed cardiac surgery on 6 patients, and 2 of them died (33.33%).

One-year survival in the SHOCK registry was 46.7% for patients in the early revascularization group compared with 33.6% in the initial medical stabilization group; and 27.9% in the surgical group [9]. In our study, the average survival rate for the entire CS population during a one

month follow-up was 66.7%. However, the influence of shorter observation time and smaller population should be considered. The technological advancements in the period between the SHOCK Trial and our study, the introduction of new devices and techniques as well as different rates of stenting could also have consequences on the statistics.

Previous trials [8,15] suggested the dominating role of STEMI in the development of CS, and our findings are consistent with those studies. CS patients who present with STEMI comprised 89.7% of all CS patients, whereas 10.3% of patients who presented with NSTEMI developed CS.

In Group 1, right ventricular infarction was most commonly associated with CS. As a consequence, we found that the RCA and LAD was the IRA in the majority of cases, whereas previous studies indicated that the LAD alone was the most common IRA [16,17].

CS developed more frequently in patients with three-vessel CAD (44.2%); CS due to left main coronary artery disease (LMCAD) occurred in 4 patients (4.6%). In previous findings, LMCAD complicated with CS was observed in 8.0–14.3% [10,18–20]. The SHOCK Trial results are consistent with those facts; however, the incidence of CS due to three-vessel CAD was 81.0% [21].

As an analysis of a single centre's experience in treating patients who present with AMI complicated with CS, our study is of great value. Because our study was confined to the population of shock patients, statistical analysis limits should be considered.

The main limitations of our study include the retrospective design, the changes in the definition of AMI during the very long inclusion period (1999–2006), the lack of treatment options (stents), and the low IABP usage rate due to the availability of the device only after 2005.

Our study has shown that in short-term follow-up, PCI is a highly efficacious procedure for CS patients. The short period of observation precluded a conclusion of significant benefits of a reduction in the transportation and door-to-needle time. This indicates the need for better organized pre-hospital care and shortening of the time from the onset of the chest pain to treatment, which will likely result in significant benefits to the patients.

References

- [1] Hochman JS, Buller CE, Sleeper LA. Cardiogenic shock complicated myocardial infarction – etiologies, management and outcome: A Report from the SHOCK Trial Registry. *J Am Coll Cardiol* 2000; 36:1063-70
- [2] Menon V, White H, LeJemtel T, Webb JG, Sleeper LA, Hochman JS. The clinical profile of patients with suspected cardiogenic shock due to predominant left ventricular failure: a report from the Shock Trial Registry. Should we emergently revascularize Occluded Coronaries in cardiogenic shock? *J Am Coll Cardiol* 2000; 36:1071-6
- [3] Jacobs AK, Leopold JA, Bates E, Mendes LA, Sleeper LA, White H et al. Cardiogenic shock caused by right ventricular infarction: a report from Shock registry. *J Am Coll Cardiol* 2003; 41:1273-9
- [4] The Joint European Society of Cardiology/American College of Cardiology Committee. Myocardial infarction redefined: A consensus document of The Joint European Society of Cardiology/American College of Cardiology Committee for the Redefinition of Myocardial Infarction. *Eur Heart J*. 2000; 21:1502-13; *J Am Coll Cardiol*. 2000; 36:959-69
- [5] Holmes DR Jr. Cardiogenic shock: A lethal complication of acute myocardial infarction. *Rev Cardiovasc Med* 2003 Summer;4(3):131-5
- [6] Bates ER, Topol EJ. Limitation of thrombolytic therapy for acute myocardial infarction complicated by congestive heart failure and cardiogenic shock. *J Am Coll Cardiol* 1991; 18:1077-84
- [7] Gruppo Italiano per lo Studio della Streptochinasi nell'Infarto Miocardico (GISSI). Effectiveness of intravenous thrombolytic treatment in acute myocardial infarction. *Lancet* 1986; 1:397-401
- [8] De Luca G, Savonitto S, Greco C, Parodi G, Dajelli Ermolli NC, Silva C et al. BLITZ Investigators Cardiogenic shock developing in the coronary care unit in patients with ST-elevation myocardial infarction. *J Cardiovasc Med (Hagerstown)*. 2008 Oct;9(10):1023-9
- [9] Hochman JS, Sleeper LA, White HD, Dzavik V, Wong SC, Menon V et al. One-Year Survival Following Early Revascularization for cardiogenic shock. *JAMA* 2001;285(2):190-192
- [10] Jeger RV, Harkness SM, Ramanathan K, Buller CE, Pfisterer ME, Sleeper LA et al. Emergency revascularization in patients with cardiogenic shock on admission: a report from the SHOCK trial and registry. *Eur Heart J*. 2006 Mar;27(6):664-70
- [11] Tarantini G, Ramondo A, Napodano M, Balato C, Isabella G, Razzolini R et al. Myocardial perfusion grade and survival after percutaneous transluminal coronary angioplasty in patients with cardiogenic shock. *Am J Cardiol*. 2004 May 1;93(9):1081-5
- [12] Ortolani P, Marzocchi A, Marrozzini C, Palmerini T, Saia F, Serantoni C et al. Clinical impact of direct referral to primary percutaneous coronary intervention following pre-hospital diagnosis of ST-elevation myocardial infarction. *Eur Heart J* 2006; 27(13):1550-7
- [13] Thiele H, Smalling RW, Schuler GC. Percutaneous left ventricular assist devices in acute myocardial infarction complicated by cardiogenic shock. *Eur Heart J*. 2007 Sep;28(17):2057-63
- [14] Santa-Cruz RA, Cohen MG, Ohman EM. Aortic counterpulsation: a review of the hemodynamic effects and indications for use. *Catheter Cardiovasc Interv*. 2006 Jan;67(1):68-77
- [15] Holmes DR Jr, Bates ER, Kleiman NS, Sadowski Z, Horgan JH, Morris DC et al. Contemporary reperfusion therapy for cardiogenic shock: the GUSTO-I trial experience. *J Am Coll Cardiol* 1995; 26:668-74
- [16] Gąsior M, Wasilewski J, Gierlotka M, Zębik T, Szkodziński J, Kondys M et al. Cardiogenic shock in the course of myocardial infarction – the results of treatment during hospitalization and in long-term follow-up. *Wiad Lek* 2003; 56(1-2):4-9
- [17] Wong SC, Sanborn T, Sleeper LA, Webb JG, Pilchik R, Hart D et al. Angiographic findings and clinical correlates in patients with cardiogenic shock complicating acute myocardial infarction: a report from the shock Trial Registry. *J Am Coll Cardiol*. 2000; 36:1077-83
- [18] Barbash IM, Behar S, Battler A, Hasdai D, Boyko V, Gottlieb S et al. Management and outcome of cardiogenic shock complicating acute myocardial infarction in hospitals with and without on-site catheterisation facilities. *Heart*. 2001 Aug;86(2):145-9
- [19] Lee MS, Tseng CH, Barker CM, Menon V, Steckman D, Shemin R et al. Outcome after surgery and percutaneous intervention for cardiogenic shock and left main disease. *Ann Thorac Surg*. 2008 Jul;86(1):29-34
- [20] White HD, Assmann SF, Sanborn TA, Jacobs AK, Webb JG, Sleeper LA et al. Comparison of percutaneous coronary intervention and coronary artery bypass grafting after acute myocardial infarction complicated by cardiogenic

shock: results from the Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock (SHOCK) trial. *Circulation*. 2005 Sep 27;112(13):1992-2001

- [21] Webb JG, Lowe AM, Sanborn TA, White HD, Sleeper LA, Carere RG et al. Percutaneous coronary intervention for cardiogenic shock in the SHOCK trial. *J Am Coll Cardiol*. 2003 Oct 15;42(8):1380-6