

# Initiation of Intra-Aortic Balloon Counterpulsation before Percutaneous Coronary Intervention in Patients with Acute Myocardial Infarction and High-Risk Features Might be Beneficial: Questions Remain

Hung-Ju Lin and Tzung-Dau Wang

Intra-aortic balloon counter-pulsation (IABP) is an intravascular mechanical device designed for temporarily assisting impaired function of left ventricular contractility, and partially mitigating compromised balance of coronary blood supply and myocardial oxygen consumption, of which both are characteristic of acute myocardial infarction (AMI). The circulatory support of IABP facilitates both the increase in cardiac output and coronary perfusion, and the decrease in myocardial oxygen demand and pulmonary artery wedge pressure via systolic unloading and diastolic augmentation. Therefore, IABP improves hemodynamic stability in AMI patients with cardiogenic shock, which develops in 5-10% of AMI patients with a high mortality rate of 40-50%.<sup>1</sup>

Given the favorable survival outcomes of registry and non-randomized studies,<sup>2,3</sup> use of IABP in patients with cardiogenic shock complicating AMI could be considered according to the current guidelines, although the suggestions are not supported by randomized controlled trials (RCT). The SHOCK trial enrolled 302 AMI patients with cardiogenic shock, of whom most received IABP treatment, and demonstrated that early revascularization by percutaneous coronary intervention (PCI) was the treatment cornerstone contributing to survival benefit.<sup>4</sup> Accordingly, the 2012 guideline of the Taiwan

Society of Cardiology (TSOC) suggests that, similar to the recommendation (Class IIa) of the 2013 ACCF/AHA guideline,<sup>5</sup> IABP could be used for stabilizing hemodynamics in patients with AMI complicated by refractory cardiogenic shock, before or during emergent revascularization.<sup>6</sup> However, the IABP-SHOCK II trial – by now, the largest RCT in this regard, included 600 AMI patients with cardiogenic shock to investigate whether survival would be improved if IABP treatment was implemented before or after early revascularization. The result did not show that IABP treatment could reduce the all-cause mortality at 30 days and 12 months.<sup>1,7</sup> Moreover, the later Cochrane meta-analysis of seven RCTs reported a similar conclusion that survival of patients with infarct-related cardiogenic shock did not benefit from IABP treatment.<sup>8</sup> Owing to the conflicting results of other observational studies and RCTs, the 2014 ESC/EACTS guideline recommends against the routine use of IABP in those patients with cardiogenic shock in the setting of acute coronary syndrome (Class III recommendation).<sup>9</sup>

How about other subgroups of AMI patients in different settings rather than cardiogenic shock, wherein IABP treatment might be beneficial? In this issue of the Journal, Sun H and his colleagues conducted a meta-analysis to explore the efficacy of IABP on mortality according to types of revascularization and timing of initiating IABP treatment.<sup>10</sup> The meta-analysis consisted of 14 RCTs published between Jan 1970 and May 2014, which assessed the effects of IABP in 2538 patients with AMI on short-term and long-term survival. It was found that, consistent with prior meta-analysis studies,<sup>8,11</sup> the mortality rates at 30 days and 6 months were not significantly different between AMI patients with or without

Received: March 6, 2017 Accepted: March 27, 2017  
Cardiovascular Center and Division of Cardiology, Department of Internal Medicine, National Taiwan University Hospital, Taipei, Taiwan.  
Corresponding author: Dr. Tzung-Dau Wang, Cardiovascular Center and Division of Cardiology, Department of Internal Medicine, National Taiwan University Hospital, Taipei, Taiwan. Tel: 886-2-2312-3456 ext. 65287; Fax: 886-2-2391-3682; E-mail: tdwang@ntu.edu.tw

IABP treatment. Neither IABP treatment provided survival benefit, irrespective of different forms of revascularization including thrombolytic therapy, PCI, or coronary artery bypass grafting. Intriguingly, in the subgroup of PCI – the main form of revascularization in this era, the authors further stratified RCTs by the timing of initiation of IABP treatment, and pointed out that, although use of IABP in AMI patients undergoing PCI did not improve survival, there appeared to be trends toward reduction in mortality rates at 30 days and 6 months in those receiving IABP treatment before PCI, relative to those after PCI. However, caution should be exercised regarding interpretation of the finding based on only three RCTs in this subgroup analysis. One reason is that summarized odds ratios might not be precisely estimated when derived from a small number of RCTs. The other explanation is that conspicuous heterogeneity of study populations between the three RCTs could lead to inherent bias on summarized estimates.

Absence of cardiogenic shock is the common characteristic of study populations in the three RCTs where IABP treatment was initiated prior to PCI. In the CRISP AMI trial,<sup>12</sup> patients with anterior ST-segment elevation myocardial infarction (STEMI) were randomized to receive prophylactic IABP treatment before primary PCI versus standard primary PCI alone. Although the result of the CRISP AMI trial did not show a survival benefit from prophylactic IABP treatment, a recent sub-study analyzed a subgroup of patients who had large STEMI and persistent ischemia after primary PCI with the features of summed ST deviation  $\geq 15$  mm at baseline, and ST resolution  $< 50\%$  after primary PCI. The result indicated that prophylactic use of IABP could contribute to a modest reduction in six-month mortality.<sup>13</sup> The second included study by GU et al. enrolled high-risk patients with acute STEMI or non-STEMI receiving prophylactic IABP treatment before PCI, of which only 70% were primary PCI.<sup>14</sup> High-risk patients were defined as those who had at least one of the following criteria: (i) intervention for left main coronary artery disease; (ii) left ventricular ejection fraction (LVEF)  $\leq 30\%$ ; (iii) pulmonary edema; and (iv) hypotension. As a result, prophylactic use of IABP was associated with a reduced risk of in-hospital and 30-day mortality, rather than 6-month mortality. The third study, the BCIS-1 trial, enrolled high-risk patients who had LVEF  $\leq 30\%$ , and extensive

coronary disease (Jeopardy score  $\geq 8/12$ ), with exclusion of those with AMI within the previous 48 hours.<sup>15</sup> Those patients were randomized to receive prophylactic use of IABP prior to PCI versus PCI alone. Although there was no difference in the 6-month mortality rate between the two groups, those with prophylactic use of IABP has a lower 12-month mortality rate, with a 34% relative reduction.<sup>16</sup>

In view of the current evidence, it would appear to be promising to extend IABP treatment for prophylactic use in the absence of cardiogenic shock before high-risk PCI, whether or not primary PCI is planned. However, routine initiation of IABP before primary PCI may delay the door-to-balloon time, which should be avoided. More studies are warranted to address the following two challenges: to establish clinical features and outcomes of high-risk patients, and to determine the timing and duration of IABP treatment. Thereafter, the benefit of IABP treatment before PCI could be clearly delineated in the setting of AMI.

## DISCLOSURES

All authors have no conflict of interest to disclose.

## CONFLICT OF INTEREST

None declared.

## REFERENCES

1. Thiele H, Zeymer U, Neumann FJ, et al. Intra-aortic balloon counterpulsation in acute myocardial infarction complicated by cardiogenic shock (IABP-SHOCK II): final 12 month results of a randomised, open-label trial. *Lancet* 2013;382:1638-45.
2. Barron HV, Every NR, Parsons LS, et al. The use of intra-aortic balloon counterpulsation in patients with cardiogenic shock complicating acute myocardial infarction: data from the National Registry of Myocardial Infarction 2. *Am Heart J* 2001;141:933-9.
3. Cheng JM, Valk SD, den Uil CA, et al. Usefulness of intra-aortic balloon pump counterpulsation in patients with cardiogenic shock from acute myocardial infarction. *Am J Cardiol* 2009;104:327-32.
4. Webb JG, Lowe AM, Sanborn TA, et al. Percutaneous coronary intervention for cardiogenic shock in the SHOCK trial. *J Am Coll Cardiol* 2003;42:1380-6.

5. O'Gara PT, Kushner FG, Ascheim DD, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: executive summary: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation* 2013;127:529-55.
6. Li YH, Yeh HI, Tsai CT, et al. 2012 guidelines of the Taiwan Society of Cardiology (TSOC) for the management of ST-segment elevation myocardial infarction. *Acta Cardiol Sin* 2012;28:63-89.
7. Thiele H, Zeymer U, Neumann FJ, et al. Intra-aortic balloon support for myocardial infarction with cardiogenic shock. *N Engl J Med* 2012;367:1287-96.
8. Unverzagt S, Buerke M, de Waha A, et al. Intra-aortic balloon pump counterpulsation (IABP) for myocardial infarction complicated by cardiogenic shock. *Cochrane Database Syst Rev* 2015: CD007398.
9. Authors/Task Force M, Windecker S, Kolh P, et al. 2014 ESC/EACTS guidelines on myocardial revascularization: the Task Force on myocardial revascularization of the European Society of Cardiology (ESC) and the European Association for cardio-thoracic surgery (EACTS) developed with the special contribution of the European Association of percutaneous cardiovascular interventions (EAPCI). *Eur Heart J* 2014;35:2541-619.
10. Sun H, Gao ZW, Zhao HM, et al. Impact of intra-aortic balloon counterpulsation on prognosis of patients with acute myocardial infarction: a meta-analysis. *Acta Cardiol Sin* 2017;33:567-77.
11. Ahmad Y, Sen S, Shun-Shin MJ, et al. Intra-aortic balloon pump therapy for acute myocardial infarction: a meta-analysis. *JAMA Intern Med* 2015;175:931-9.
12. Patel MR, Smalling RW, Thiele H, et al. Intra-aortic balloon counterpulsation and infarct size in patients with acute anterior myocardial infarction without shock: the CRISP AMI randomized trial. *JAMA* 2011;306:1329-37.
13. van Nunen LX, van't Veer M, Schampaert S, et al. Intra-aortic balloon counterpulsation reduces mortality in large anterior myocardial infarction complicated by persistent ischaemia: a CRISP-AMI substudy. *EuroIntervention* 2015;11:286-92.
14. Gu J, Hu W, Xiao H, et al. Prophylactic intra-aortic balloon pump reduces C-reactive protein levels and early mortality in high-risk patients undergoing percutaneous coronary intervention. *Acta Cardiol* 2011;66:499-504.
15. Perera D, Stables R, Thomas M, et al. Elective intra-aortic balloon counterpulsation during high-risk percutaneous coronary intervention: a randomized controlled trial. *JAMA* 2010;304:867-74.
16. Perera D, Stables R, Clayton T, et al. Long-term mortality data from the balloon pump-assisted coronary intervention study (BCIS-1): a randomized, controlled trial of elective balloon counterpulsation during high-risk percutaneous coronary intervention. *Circulation* 2013;127:207-12.

