Editorial

Intra-aortic balloon pump during venoarterial extracorporeal membrane oxygenation: still a matter of debate? Contemporary multi-device approach to cardiogenic shock

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Provenance: This is an invited Editorial commissioned by the Section Editor Lei Huang (Cardiac Center of Tianjin Third-Central Hospital, Tianjin, China).

Comment on: Aso S, Matsui H, Fushimi K, *et al*. The Effect of Intraaortic Balloon Pumping Under Venoarterial Extracorporeal Membrane Oxygenation on Mortality of Cardiogenic Patients: An Analysis Using a Nationwide Inpatient Database. Crit Care Med 2016;44:1974-9.

Submitted Mar 13, 2017. Accepted for publication Mar 22, 2017.
doi: 10.21037/jtd.2017.03.188
View this article at: http://dx.doi.org/10.21037/jtd.2017.03.188

Acute cardiogenic shock still represents a life-threating condition, even though great improvements and innovations have been introduced in the last years in this field. Mortality is high whatever the cause, and despite specific therapies targeted to the primary disorder (revascularisation, surgery, antiarrhythmics and immunosuppressants). So far, it is clear that this syndrome, with a stable mortality rate >40% as reported in most recent literature (1), requires a specific therapy. On top of medical therapy, mechanical circulatory support has emerged as the mainstay treatment for cardiogenic shock (1,2).

Venoarterial extracorporeal membrane oxygenation (VA ECMO) presents unique features which have made it the more suitable device in this context, namely the rapid availability and ease for set up, the high reperfusive flow, the biventricular and pulmonary support provided.

As a result of transition from complex and bulky system to simple circuits and machines, it has now become of common use in clinical practice to treat a wide range of shock conditions up to out of hospital refractory cardiac arrest.

No large controlled trial has, however, so far addressed the application of VA ECMO in the setting of cardiogenic shock and studies to summarize experiences in managing and running ECMO support are strongly warranted. Some issues of VA ECMO therapy are, indeed, still open: above all, unloading of the left ventricle, which represents the Achilles' heel of this treatment (3). The arterial perfusion provided during peripheral VA ECMO is retrograde, and the increased afterload on the dysfunctional left ventricle may lead to lung overload up to pulmonary oedema (4). This is a detrimental hemodynamic effect, which may jeopardize the benefits of VA ECMO treatment itself.

The need for left ventricle venting during VA ECMO has been addressed with several approaches including balloon and blade atrial septostomy, left atrial decompression with transeptal puncture, a surgically placed left ventricular (LV) venting, a percutaneous LV assist device and an intra-aortic balloon pump (IABP). We don't think that IABP is useful during VA ECMO for a supposed "perfusion benefit" which indeed is overcome by ECMO blood flow: on the contrary, the rationale of the combined use of VA ECMO and IABP is to provide a pressure unloading to the left ventricle. As a matter of fact, this mechanical circulatory support should be already in place at the time of VA ECMO implantation, as stated by ELSO Guidelines. As a result, it is not the opportunity of its implantation, rather its removal to be discussed.

In the present article (5), the authors analyzed a huge number of ECMO patients from a nationwide inpatient database, including more than 90% of all tertiary-care emergency hospitals in Japan. They compared a group of patients treated with VA ECMO alone with a group of patients who received multidevice mechanical circulatory support with VA ECMO and IABP, using propensity score matching.

The primary outcome was all-cause 28-day mortality

and in-hospital mortality, and the secondary outcome was the proportion of patients weaned from VA ECMO. The authors observed lower 28-day mortality (48.4% *vs.* 58.2%; P=0.001), lower in-hospital mortality (55.9% *vs.* 64.5%; P=0.004) and higher rate of VA ECMO weaning (82.6% *vs.* 73.4%; P<0.001) in the IABP combined with VA ECMO group than the VA ECMO-alone group.

The high number of patients included in the study, and the propensity matched analysis with a control group are strengths of this analysis. Another study, published in 2014, on 135 hemodynamically compromised patients treated with a combination of VA ECMO and IABP showed positive results in terms of in-hospital survival, bridge to recovery or next therapy, but a control group was not present (6). This preliminary evidence was challenged by other contemporary studies (7,8), and by a meta-analysis showing no benefits in term of survival for patients treated with IABP on top of VA ECMO compared to ECMO alone (9).

Beyond literature itself, it should be underlined that the IABP is the more simple mechanical support device to provide unloading, it can be inserted percutaneously at bedside and it is often already in place before VA ECMO cannulation, especially in those patients which are transferred to a referral center to undergo mechanical circulatory support treatment.

The real effective degree of left ventricle unloading provided by the IABP in patients with VA ECMO is very difficult to assess and might be questionable. Besides, it can be still inadequate in extremely severe cases with massive pulmonary oedema: in such cases, for example after extracorporeal cardiopulmonary resuscitation (E-CPR) a more consistent unloading is provided. Out-of-hospital resuscitated patients were not included in this study, therefore the role of IABP for patients treated with ECLS in the setting of cardiac arrest should be further evaluated. Right now, however, the applicability of surgical unloading strategies, which may be theoretically more effective is limited in the context of critical patients and reserved as a rescue treatment. On one hand, the percutaneous VA ECMO represents the only feasible strategy for prompt deployment of short term mechanical support in a critically ill patient. On the other side, it cannot provide LV venting, which is crucial for the recovery of the lungs and, as a consequence, for every further next strategy, from weaning to upgrading to permanent support or heart transplantation. For this reason, we think that modern contemporary approach to mechanical circulatory support should be completely percutaneous and extrathoracic and should include a percutaneous LV unloading device as well. In this perspective, we believe that the role of IABP in patients suffering from cardiogenic shock should be highlighted as:

(I) It is rapidly deployable at any hospital and therefore reduces the duration of "uncontrolled shock".
(II) It allows, thereafter, safe transport to MCS units.
(III) It does allow foe exploiting the same vascular access for Impella implant (10).
(IV) It has a major role in weaning from VA ECMO and therefore reduces the burden of the complications related to ECLS.

In conclusion, current approach to cardiogenic shock implies the use of multiple devices: all of them percutaneous and with no need of surgery. A combined use of IABP and VA ECMO or Impella and VA ECMO are well described approaches: they can improve the hemodynamics facilitating and supporting conditions for recovery or ventricular assist device implantation (6,11,12). We strongly believe that prompt implantation of IABP would significantly impact the management of cardiogenic shock as it would avoid the administration of "toxic doses" of inotropes, allow for smoother transition to VA ECMO and for routine unloading of the LV. Management of "stone heart", refractory VT/VF, aortic regurgitation are challenging issues in VA ECMO that require specific patient tailored approaches. Active percutaneous transaortic LVADs are the next step and, indeed, can improve survival in this scenario; further technological improvements are warranted, however, for their routine application.

Acknowledgements

The study was supported by departmental funds.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Cite this article as: Scandroglio AM, Pieri M, Pappalardo F, Landoni G. Intraaortic balloon pump during venoarterial extracorporeal membrane oxygenation: still a matter of debate? Contemporary multi-device approach to cardiogenic shock. J Thorac Dis 2017;9(5):E522-E524. doi: 10.21037/jtd.2017.03.188

