

Left ventricular distention under venoarterial extracorporeal membrane oxygenation support: when should we consider percutaneous left heart decompression?

Mounir Riahi¹, Alban-Elouen Baruteau^{2,3,4}

¹Department of Cardiology, St Paul's Hospital, University of British Columbia, Vancouver, Canada; ²Department of Congenital Cardiology, Evelina London Children's Hospital, Guy's and St Thomas' NHS Foundation Trust, London, UK; ³M3C CHU de Nantes, Fédération des Cardiopathies Congénitales, Nantes, France; ⁴IHU LIRYC, Electrophysiology and Heart Modeling Institute, Bordeaux, France

Correspondence to: Dr. Alban-Elouen Baruteau, MD, PhD. Paediatric Cardiology, Becket House 4th floor, Westminster Bridge Road, London SE1 7EH, UK. Email: alban-elouen.baruteau@u-bordeaux.fr.

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

Comment on: Truby LK, Takeda K, Mauro C, *et al.* Incidence and Implications of Left Ventricular Distention During Venous Arterial Extracorporeal Membrane Oxygenation Support. *ASAIO J* 2017;63:257-65.

Submitted Nov 09, 2017. Accepted for publication Nov 14, 2017.

doi: 10.21037/jtd.2017.11.97

View this article at: <http://dx.doi.org/10.21037/jtd.2017.11.97>

In the June 2017 issue of the *ASAIO Journal*, Truby *et al.* described a retrospective, monocenter cohort of 121 patients who underwent veno-arterial extracorporeal membrane oxygenation (VA-ECMO) implantation because of refractory cardiogenic shock (1). Authors stratified patients in three distinct groups according to a new proposed definition of left ventricular distention (LVD) severity based on clinical, hemodynamic and radiologic criteria: (I) clinical LVD (LVD++) if “mechanical intervention to decompress the LV was initiated immediately after VA-ECMO because of pulmonary edema, ventricular arrhythmia, or significant stagnation of blood within the LV”; (II) subclinical LVD (LVD+) if “evidence of pulmonary edema on chest radiograph and pulmonary artery diastolic pressure greater than 25 mmHg within the first 2 hours of VA-ECMO support”; and (III) no LVD (LVD-) in the absence of the above criteria.

Significant baseline differences existed between groups: 33% of LVD++ patients had post myocardial infarction refractory cardiogenic shock while 55% of LVD+ had postcardiotomy shock. More importantly, cardiopulmonary resuscitation was performed in 67% of LVD++ compared to 11% and 19% of LVD+ and LVD-, respectively. Furthermore, all LVD++ patients had an LV ejection fraction lower than 30% compared to 50%

in the LVD+ group and 40% in the LVD-. After a mean duration of VA-ECMO support of 4.11±2.98 days, the overall survival to discharge was 43% and did not differ between groups. However, only 20% of LVD++ survivors achieved myocardial recovery defined as absence of long-term mechanical support. In comparison, 60% of LVD+ and 20% of LVD- achieved myocardial recovery. One major finding was that survival to discharge was 44.4% (4/9) in those patients who benefited from early decompression, all of which were in the LVD++, versus only 10% (1/10) in those of the LVD+ group who underwent a late decompression. The only preoperative factor that was significantly predictive of the need of decompression in the multivariate model was extracorporeal cardiopulmonary resuscitation (odds ratio: 3.64, confidence interval: 1.21–10.98; P=0.022).

Although the results are interesting, authors advocate significant limitations that may have impacted the interpretation of study findings. Only 105 out of 226 VA-ECMO runs were included in the analysis, the other ones being excluded because of insufficient hemodynamic data. Preoperative echocardiographic data were not available for most of the patients and were not to be included in the analysis, which is a major drawback. The proposed definition of LVD may thus be controversial as it does

not include any echocardiographic criteria demonstrating ventricular distention, elevated filling pressures and reduced aortic valve opening. Furthermore, in the absence of defined criteria to initiate an immediate decompression therapy, patients who have been included in LVD++ group in this study could have been reclassified in another group depending on the treating team threshold for mechanical decompression.

Refractory cardiogenic shock may be due to either acute myocarditis or non-myocarditis cardiac diseases, mainly including end-stage dilated cardiomyopathy, ischaemic cardiomyopathy and postcardiotomy shock. Although development of pharmacological therapies along with advances in mechanical circulatory support facilities have led to a substantial reduction of its mortality rate, cardiogenic shock still carries a poor prognosis (2,3). VA-ECMO is widely used for oxygenation and circulatory support for neonates, children and adults whose hearts and lungs can no longer provide adequate physiologic support despite conventional therapies (4-6). In these patients, VA-ECMO may be considered as a bridge to recovery, to left ventricular assist device (LVAD) implantation or to heart transplantation (5). Alongside hemodynamic improvement, use of VA-ECMO may be associated with severe complications such as compartment syndrome, leg necrosis, sepsis, vascular injury, intra-cerebral hemorrhage or stroke (4). VA-ECMO can also have a negative hemodynamic impact on the left ventricle as retrograde flow generated from the arterial cannula can increase the afterload of the left ventricle and lead to LVD. Persistently high left ventricular filling pressures and volumes can lead to high myocardial oxygen demand (7), such that VA-ECMO alone may not significantly reduce wall stress (8,9). This may compromise myocardial recovery and prolong the resulting lung injury unless the left heart is vented or unloaded. Several techniques have been described in order to decompress the failing left heart, including intra-aortic balloon pumps (IABPs), axial flow catheters (Impella, Abiomed Inc., Danvers, MA, USA) and left atrial to femoral artery bypass (TandemHeart, Cardiac Assist Inc., Pittsburgh, PA, USA) (10,11). Left heart decompression has also been achieved by the transcatheter creation of an atrial septal defect using different approaches, including vent placement, static balloon dilation and stent implantation (12-14).

Although subclinical and clinical LVD are increasingly recognized in routine practice, there is a paucity of data to help predict the occurrence of LVD under VA-ECMO.

Moreover LVD management remains controversial among groups and there is no evidence regarding the best timing to consider left heart decompression in these patients (5). Although sometimes straightforward, decision-making is most of the time complex and multifactorial and should include clinical, echocardiographic, haemodynamic and radiographic data.

Authors should be commended for this brilliant study and for their efforts in offering an algorithm for the initial evaluation of patients with refractory cardiogenic shock. Because of the relatively limited number of patients as well as missing echocardiographic data, several crucial questions remain unanswered however. Proper criteria for patients selection, the best strategy to decompress the failing left heart, the cost effectiveness of various offered approaches, and last but not least the accurate timing to consider LV decompression needs to be further addressed. As the medical community still needs stronger evidence on a large patients scale, a prospective randomized multicenter trial would be helpful to improve our practice and save lives in VA-ECMO patients.

Acknowledgements

None.

Footnote

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

References

1. Truby LK, Takeda K, Mauro C, et al. Incidence and Implications of Left Ventricular Distention During Venoarterial Extracorporeal Membrane Oxygenation Support. *ASAIO J* 2017;63:257-65.
2. Kolte D, Khera S, Aronow WS, et al. Trends in incidence, management, and outcomes of cardiogenic shock complicating ST-elevation myocardial infarction in the United States. *J Am Heart Assoc* 2014;3:e000590.
3. De Luca L, Olivari Z, Farina A, et al. Temporal trends in the epidemiology, management, and outcome of patients with cardiogenic shock complicating acute coronary syndromes. *Eur J Heart Fail* 2015;17:1124-32.
4. Miller PE, Solomon MA, McAreavey D. Advanced Percutaneous Mechanical Circulatory Support Devices for Cardiogenic Shock. *Crit Care Med* 2017;45:1922-9.

5. Kleinman ME, Chameides L, Schexnayder SM, et al. Part 14: pediatric advanced life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 2010;122:S876-908.
6. Lawler PR, Silver DA, Scirica BM, et al. Extracorporeal membrane oxygenation in adults with cardiogenic shock. *Circulation* 2015;131:676-80.
7. Douflé G, Roscoe A, Billia F, et al. Echocardiography for adult patients supported with extracorporeal membrane oxygenation. *Crit Care* 2015;19:326.
8. Kapur NK, Zisa DC. Venous-arterial extracorporeal membrane oxygenation (VA-ECMO) fails to solve the haemodynamic support equation in cardiogenic shock. *EuroIntervention* 2016;11:1337-9.
9. Burkhoff D, Sayer G, Doshi D, et al. Hemodynamics of Mechanical Circulatory Support. *J Am Coll Cardiol* 2015;66:2663-74.
10. Werdan K, Gielen S, Ebelt H, et al. Mechanical circulatory support in cardiogenic shock. *Eur Heart J* 2014;35:156-67.
11. Rihal CS, Naidu SS, Givertz MM, et al. 2015 SCAI/ACC/HFSA/STS Clinical Expert Consensus Statement on the Use of Percutaneous Mechanical Circulatory Support Devices in Cardiovascular Care: Endorsed by the American Heart Association, the Cardiological Society of India, and Sociedad Latino Americana de Cardiologia Intervencion; Affirmation of Value by the Canadian Association of Interventional Cardiology-Association Canadienne de Cardiologie d'intervention. *J Am Coll Cardiol* 2015;65:e7-26.
12. Eastaugh LJ, Thiagarajan RR, Darst JR, et al. Percutaneous left atrial decompression in patients supported with extracorporeal membrane oxygenation for cardiac disease. *Pediatr Crit Care Med* 2015;16:59-65.
13. Baruteau AE, Barnette T, Morin L, et al. Percutaneous balloon atrial septostomy on top of venoarterial extracorporeal membrane oxygenation results in safe and effective left heart decompression. *Eur Heart J Acute Cardiovasc Care* 2016. [Epub ahead of print].
14. Lin YN, Chen YH, Wang HJ, et al. Atrial Septostomy for Left Atrial Decompression During Extracorporeal Membrane Oxygenation by Inoue Balloon Catheter. *Circ J* 2017;81:1419-23.

Cite this article as: Riahi M, Baruteau AE. Left ventricular distention under venoarterial extracorporeal membrane oxygenation support: when should we consider percutaneous left heart decompression? *J Thorac Dis* 2017;9(12):4919-4921. doi: 10.21037/jtd.2017.11.97