Preface

The evolution of mechanical circulatory support (MCS): a new wave of developments in MCS and heart failure treatment

Cardiovascular diseases and heart failure (HF) remain one of the major causes of worldwide mortality. According to the American Heart Association, 85.6 million adults in the US suffer from cardiovascular diseases, out of which 5.7 million are living with HF (1). Decades of dedicated efforts on clinical as well as technological aspects of mechanical circulatory support (MCS) devices have led to their widespread success and acceptance for the treatment of advanced HF. Ventricular assist devices are key players in the MCS field. Left ventricular assist devices (LVADs) are a promising treatment option for HF due to the dearth of available donor organs for cardiac transplantation, despite the increasing number of patients on waiting lists (2). As per the annual INTERMACS reports, over 13,000 patients in the US received LVAD support in 2014 (3). Long-term follow-up studies of the newest generation of LVADs, including the HeartMate 3 (Abbott, North Chicago, IL, USA) and HVAD (Medtronic, Minnesota, MS, USA) have revealed high patient survival rates and reduced post-operative complication rates (4,5). These results indicate the widespread success of LVAD therapy as a promising treatment option for advanced HF. This issue therefore combines a wide array of articles in the field of MCS with a special focus on the current state of the art—LVADs.

The improved pump design and further miniaturization of the newest generation of LVADs have led to significantly improved clinical outcome. Such technological aspects of LVADs along with their clinical performance have been reviewed and discussed in articles by Chatterjee *et al.*, as part of this focused issue (6,7). Pump miniaturization has greatly facilitated the development of less or minimally invasive surgical techniques for LVAD implantation, which have in turn reduced post-operative complications such as bleeding and surgical trauma. In this issue Schmitto *et al.* describes a successful, less invasive surgical strategy for HeartMate 3 implantation (8). This surgical technique, which was initially developed in Hannover ("Hannover VAD-technique") (9) is associated with many advantages (less trauma, less bleeding less right heart failure, better outcome) and tips and tricks of this less invasive technique have been presented by Deniz *et al.* (10). Wert *et al.* and Ricklefs *et al.* demonstrate how such minimally invasive LVAD implantation techniques can improve cardiogenic shock patient outcome as well as renal function respectively (11,12). Furthermore, left ventricular dysfunction in HF patients is often found to be associated with mitral valve regurgitation, often warranting challenging multifactorial surgical strategies. Dogan *et al.* presented a study on this topic where HF patients treated with a novel device for transcatheter mitral valve repair prior to LVAD implantation in order to treat both mitral valve regurgitation and ventricular dysfunction (13).

Right HF, pump thrombosis and LVAD-related infections are some of the most common complications observed after LVAD implantation and have been associated with mortality and re-hospitalization. Ricklefs *et al.* presented data on the outcome of the worldwide first successful HeartMate 3 implantation as a treatment for right HF (14). The same group also described a novel surgical tool for myocardial recovery after LVAD implantation (15). Pump thrombosis is a particularly severe post-operative complication and is often treated by lysis therapy. Wert *et al.*, demonstrated the incorporation of direct thrombin inhibitors such as argatroban as a thrombosis management strategy (16). In cases where lysis therapy proves unsuccessful, surgical interventions such as pump exchange are warranted. Hanke *et al.* explored the feasibility of minimally invasive pump exchange as a treatment for pump thrombosis in LVAD patients and associated complications (17). Timely detection of suspected LVAD pump thrombosis may reduce the need for surgical intervention and control related complications. Therefore currently, considerable research is focused on the detection of pump thrombosis, as demonstrated by Feldmann *et al.* who presented data from a study on an acoustic detection method for testing artificial thrombus models (18). In cases where pump exchange is an inevitable treatment option, less invasive surgical strategies and innovative devices that facilitate less invasiveness will help reduce further post-operative complications in patients (15). Another critical post-operative complication associated with LVAD-related re-hospitalization and mortality is the occurrence of LVAD-driveline infections. This topic has been addressed by Wert *et al.* who presented a surgical approach for reducing driveline infections (19). Current research efforts are focused not only on improving patient survival and complication rates but also on LVAD patient aftercare, improving patient quality of life and functional capacity. This topic has been explored in detail by Schmidt *et al.* and Reiss *et al.* (20,21).

The positive clinical outcomes of LVAD-implantation in European and American patient populations have led to the creation of international VAD programs and adoption of this treatment option for HF in other countries as well. This issue highlights some of the initial experiences of VAD implantation programs which have been developed to address the needs of diverse patient populations. These include studies by Nestorovic *et al.*, Pedemonte *et al.* and Tarazi *et al.* who have documented initial experiences with LVAD implantation in Serbia, Chile and Kuwait respectively (22-24).

Cardiological diagnoses and interventions are other integral parts of HF management. A study by Berliner *et al.* has discussed the role of cardiological intervention in the management of cardiovascular diseases such as myocardial ischemia (25). Cardiological interventions may also involve cell-based approaches such as stem cell transplantation for myocardial regeneration, a topic which has been reviewed by Rao *et al.* (26). HF in adult patients can also arise from inborn disorders, characterized by ventricular arrhythmias and possess an increased risk of mortality due to sudden cardiac death. Such patients may be treated by implantable cardioverter defibrillator therapy, as shown by Hohmann *et al.* (27). Some patients suffering from HF may be afflicted with respiratory failure as well and require cardiopulmonary support, till recovery or intervention by long-term MCS. This is often performed using extracorporeal membrane oxygenation (ECMO) devices, which has been reviewed by Lescouflair *et al.* (28).

MCS and LVAD treatment algorithms and management procedures are dynamic processes. The evolution of miniaturized LVAD pump design and less invasive surgical strategies have considerably improved patient survival and quality of life. However further surgical and engineering efforts in parallel to interdisciplinary approaches focused on better control of post-operative complications, patient aftercare and cost-effectiveness is warranted to advance the current state of the art.

Acknowledgements

None.

References

1. Writing Group Members, Mozaffarian D, Benjamin EJ, et al. Heart Disease and Stroke Statistics-2016 Update: A Report From the American Heart Association. Circulation 2016;133:e38-360. Erratum in: Circulation 2016;133:e599.
2. Schmitto JD, Hanke JS, Rojas SV, et al. First implantation in man of a new magnetically levitated left ventricular assist device (HeartMate III). J Heart Lung Transplant 2015;34:858-60.
3. Kirklin JK, Naftel DC, Pagani FD, et al. Seventh INTERMACS annual report: 15,000 patients and counting. J Heart Lung Transplant 2015;34:1495-504.
4. Mehra MR, Goldstein DJ, Uriel N, et al. Two-Year Outcomes with a Magnetically Levitated Cardiac Pump in Heart Failure. N Engl J Med 2018;378:1386-95.
5. Schmitto JD, Zimpfer D, Fiane AE, et al. Long-term support of patients receiving a left ventricular assist device for advanced heart failure: a follow-up analysis of the Registry to Evaluate the HeartWare Left Ventricular Assist System. Eur J Cardiothorac Surg 2016;50:834-8.
6. Chatterjee A, Feldmann C, Hanke JS, et al. The momentum of HeartMate 3: a novel active magnetically levitated centrifugal left ventricular assist device (LVAD). J Thorac Dis 2018;10:S1790-3.
7. Chatterjee A, Feldmann C, Dogan G, et al. Clinical overview of the HVAD: a centrifugal continuous-flow ventricular assist device with magnetic and hydrodynamic bearings including lateral implantation strategies. J Thorac Dis 2018;10:S1785-9.
8. Schmitto JD, Krabatsch T, Damme L, et al. Less invasive HeartMate 3 left ventricular assist device implantation. J Thorac Dis 2018;10:S1692-5.
9. Schmitto JD, Molitoris U, Haverich A, et al. Implantation of a centrifugal pump as a left ventricular assist device through a novel, minimized approach: upper hemisternotomy combined with anterolateral thoracotomy. J Thorac Cardiovasc Surg 2012;143:511-3.
10. Deniz E, Chatterjee A, Feldmann C, et al. How to do it: tips and tricks of minimal-invasive HVAD® implantation—the lateral approach. J Thorac Dis 2018;10:S1829-33.
11. Wert L, Chatterjee A, Dogan G, et al. Minimally invasive surgery improves outcome of left ventricular assist device surgery in

in cardiogenic shock. J Thorac Dis 2018;10:S1696-702.
12. Ricklefs M, Heimeshoff J, Hanke JS, et al. The influence of less invasive ventricular assist device implantation on renal function. J Thorac Dis 2018;10:S1737-42.
13. Dogan G, Hanke JS, Ricklefs M, et al. MitraClip procedure prior to left ventricular assist device implantation. J Thorac Dis 2018;10:S1763-8.
14. Ricklefs M, Hanke JS, Dogan G, et al. Successful HeartMate 3 implantation in isolated right heart failure—first in man experience of right heart configuration. J Thorac Dis 2018;10:S1834-7.
15. Ricklefs M, Deodhar C, Chatterjee A, et al. A new tool for an explantation strategy of HeartMate 3™ left ventricular assist device. J Thorac Dis 2018;10:S1825-8.
16. Wert L, Hanke JS, Dogan G, et al. Argatroban administration as therapy for thrombosis in patients with continuous-flow ventricular assist devices. J Thorac Dis 2018;10:S1720-7.
17. Hanke JS, Dogan G, Wert L, et al. Left ventricular assist device exchange for the treatment of HeartMate II pump thrombosis. J Thorac Dis 2018;10:S1728-36.
18. Feldmann C, Deniz E, Stomps A, et al. An acoustic method for systematic ventricular assist device thrombus evaluation with a novel artificial thrombus model. J Thorac Dis 2018;10:S1711-9.
19. Wert L, Hanke JS, Dogan G, et al. Reduction of driveline infections through doubled driveline tunneling of left ventricular assist devices—5-year follow-up. J Thorac Dis 2018;10:S1703-10.
20. Schmidt T, Bjarnason-Wehrens B, SchulteEistrup S, et al. Effects of pump speed changes on exercise capacity in patients supported with a left ventricular assist device—an overview. J Thorac Dis 2018;10:S802-10.
21. Reiss N, Schmidt T, Boeckelmann M, et al. Telemonitoring of left-ventricular assist device patients—current status and future challenges. J Thorac Dis 2018;10:S1794-801.
22. Nestorovic E, Schmitto JD, Kushwaha SS, et al. Successful establishment of a left ventricular assist device program in an emerging country: one year experience. J Thorac Dis 2018;10:S1743-50.
23. Pedemonte O, Vera A, Merello L, et al. Left ventricular assist device (LVAD) program in Chile: first successful experience in South America. J Thorac Dis 2018;10:S1751-7.
24. Tarazi R, Ridha M, Shammsah M, et al. Left ventricular assist device therapy: the Kuwait experience. J Thorac Dis 2018;10:S1758-62.
25. Berliner D, Maier LS, Wollenberg U, et al. Clinical care for patients with recurrent myocardial ischemia in Germany—the VOICES trial. J Thorac Dis 2018;10:S1777-84.
26. Rao P, Skaria R, Khalpey Z. Regenerative concepts in cardiovascular research: novel hybrid therapy for remodeling ischemic cardiomyopathy. J Thorac Dis 2018;10:S1819-24.
27. Hohmann S, Duncker D, König T, et al. Implantable cardioverter defibrillator therapy in grown-up patients with transposition of the great arteries—role of anti-tachycardia pacing. J Thorac Dis 2018;10:S1769-76.
28. Lescouflair T, Figura R, Tran A, et al. Adult veno-arterial extracorporeal life support. J Thorac Dis 2018;10:S1811-8.

Anamika Chatterjee

Jan D. Schmitto

Anamika Chatterjee
(Email: Chatterjee.Anamika@mh-hannover.de)
Jan D. Schmitto
(Email: Schmitto.Jan@mh-hannover.de)
Department of Cardiothoracic, Transplantation and Vascular Surgery, Hannover Medical School, Hannover, Germany.
doi: 10.21037/jtd.2018.05.205
Conflicts of Interest: JD Schmitto is a consultant for Abbott and Medtronic. A Chatterjee has no conflicts of interest to declare.
View this article at: http://dx.doi.org/10.21037/jtd.2018.05.205

Cite this article as: Chatterjee A, Schmitto JD. The evolution of mechanical circulatory support (MCS): a new wave of developments in MCS and heart failure treatment. J Thorac Dis 2018;10(Suppl 15):S1688-S1691. doi: 10.21037/jtd.2018.05.205

