Interactive CardioVascular and Thoracic Surgery 33 (2021) 793–794
doi:10.1093/icvts/ivab208 Advance Access publication 18 August 2021

INVITED COMMENTARY

Cite this article as: Lorusso R, Ravaux JM, Mariani S. Left ventricular assist devices and right ventricular failure prediction: Quo Vadis? Interact CardioVasc Thorac Surg 2021;33:793–4.

Left ventricular assist devices and right ventricular failure prediction: Quo Vadis?

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Keywords: Right ventricular failure • Left ventricular assist device • Mechanical circulatory support • Echocardiography • Risk prediction

The role of left ventricular assist devices (LVADs) as circulatory support in end-stage heart failure has been increasingly emphasized [1]. Despite advancements in technical aspects, perioperative management, and surgical approaches, several other issues still negatively influence LVAD-related outcomes. Among them, right ventricular failure (RVF) remains a cumbersome complication affecting up to 40% of LVAD patients [2]. Severe RVF requiring the implant of a right ventricular assist device is associated with a survival which may be as low as 58% at 1 year and 31% at 5 years [1–3]. Based on these data, both scientific and clinical communities have invested efforts to describe, define, predict, prevent and treat post-LVAD RVF [4]. Nevertheless, the overall RVF dilemma is still unsolved.

Besides the therapeutic approach, the two other main challenges regarding post-LVAD RVF are definition and prediction. RVF is a clinical entity with a continuous spectrum of severity grades, and direct effects on patients soon after surgery (early RVF) or months after implantation (late RVF). Early and late RVF own different pathophysiological patterns. Therefore, their definitions, diagnosis and predictions are expected to differ from each other. The Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS) has given the most accepted definition of post-LVAD RVF, identifying a severity grading scale with different parameters for early and late RVF. Despite the presence of these reference points, post-LVAD RVF is still heterogeneously defined in research studies and often no distinction is clearly made between early and late RVF [5]. This is true also for studies on predictive RVF risk scores. On the other hand, the precise recognition and distinction of the risks for early or late RVF are crucial, since related underlying mechanisms and managements differ substantially ranging from preventive measures, like temporary mechanical circulatory support [6], to long-term options, like durable right ventricular assist devices [7]. It is, thus, essential to adopt 'universal' definitions of post-LVAD RVF and distinguish between early and late RVF in all future attempts of RVF risk prediction.

The complexity and difficulty of predicting RVF after LVAD implantation rise even further. Literature reports 20 distinct risk prediction models for RVF in adults undergoing LVAD implantation [5]. Of the 20 models, only 7 have been validated in at least 2 external cohorts and principally demonstrated poor discrimination with unreported calibration [5]. Among these 7 models, the EUROMACS, Penn and CRITT models include preoperative echocardiography [8]. EUROMACS and Penn model comprise severe right ventricular (RV) dysfunction determined on visual score [8]. The CRITT model includes severe RV dysfunction determined upon RV contractility, tricuspid regurgitation and tricuspid annular motion [8]. Nevertheless, all these parameters are qualitative measures of RV contractility and can be affected by significant inter- and intra-observer variability. Moreover, these measures are difficult to be assessed in patients supported with preoperative extracorporeal life support, a condition that represents a diagnostic challenge, impeding any clear assessment of the actual RV state and function. Notwithstanding, preoperative extracorporeal life support is used in a not negligible rate of patients [9] and more efforts are needed to identify objective tools for RVF prediction in this specific population.

Finally, therapy objective, whether destination therapy or bridge to heart transplant, may also represent an additional variable to be considered, since managing the occurrence of RVF will unquestionably warrant different decision-making strategies.

The article by Chriqui and colleagues [10] explores the predictive value of 3 echocardiographic parameters: tricuspid annular plane systolic excursion, RV fractional area change and RV global longitudinal strain. So far, these parameters have not been studied in large-scale trials and are not part of the most used RVF risk scores. The reason might be related to the technical challenges in echocardiographic visualization of the RV to obtain reliable data. Nevertheless, Chriqui and colleagues remind us that a more detailed functional workup is clearly needed for LVAD patients, and perhaps a more sophisticated diagnostic process is required to further elucidate the actual RV myocardial quality and ability to sustain post-LVAD circulatory and anatomical conditions.

On the other hand, future technologies may play a pivotal role. Until now, it has been attempted to assess the RVF risk with traditional tools such as scores and models, evaluating single parameters and hoping that one of these could provide the key solution to the RVF problem. However, it's progressively more evident that the solution is hidden in a more complex interaction

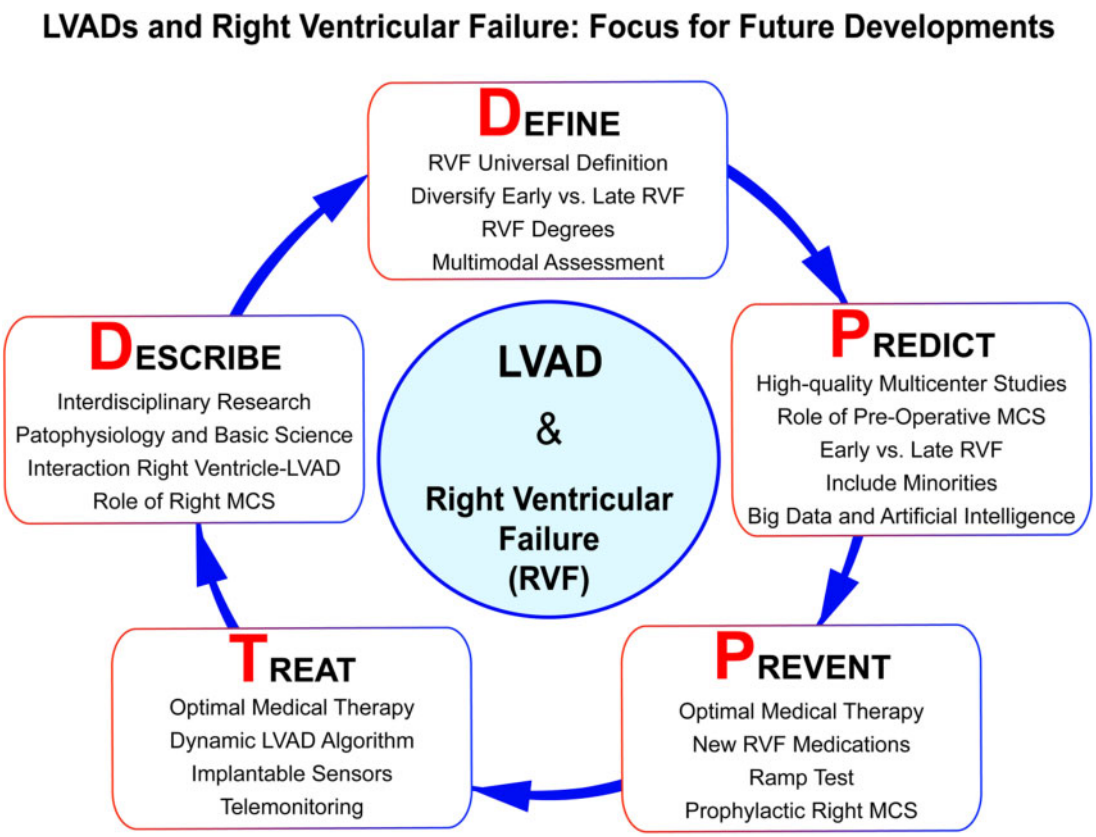

Figure 1: Goals and focus points for future developments and research in the field of right ventricular failure and left ventricular assist devices. LVAD: left ventricular assist device; RVF: right ventricular failure.

among variables [10] which might be better explored through data analysis and artificial intelligence. Undeniably, artificial intelligence has already transformed the field of cardiovascular medicine from accurate cardiovascular risk prediction to automated image segmentation, from artificial intelligence-guided treatments to improved efficiency, from accurate diagnosis to improved prognosis and cost reduction.

In conclusion, the contribution by Chriqui and colleagues emphasizes the importance of considering every parameter to reconstruct the complex picture of RVF, but also the overall inadequate understanding of RVF and the meagre prediction ability of available tools. Structured and joined efforts for further and more in-depth research (Fig. 1), with a focus to new technologies, are urgently required to find the way out from the labyrinth of RVF.

Conflict of interest: Roberto Lorusso is a consultant for Medtronic, Getinge and LivaNova, and an Advisory Board Member of Eurosets: all honoraria are paid to the University for research support.

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