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Personalizing care in cardiogenic shock: Searching for a common hemodynamic language

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ABSTRACT

The increased availability and utilization of acute mechanical circulatory support use in cardiogenic shock has led to an increased need for multidisciplinary communication with specialized shock centers. The wide variability of hemodynamic data and local expertise raises a unique communication problem in capturing and documenting necessary information to guide decision making.

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We here discuss the need for a unified communication/language in the era of cardiogenic shock with acute mechanical support devices. We furthermore propose a conceptual outline of the necessary information required in daily documentation and bedside evaluation to optimize clinical decision making.

The care of patients with cardiogenic shock (CS) has changed dramatically with the increased availability and utilization of acute mechanical circulatory support (AMCS) predominantly studied in acute myocardial infarction (AMI) which carries an unacceptably high mortality.[1–5] Despite increasing utilization, there is no consensus that supports best practices on how to approach CS beyond diagnosis and/or after AMCS is instituted.[6] Critical care of patients on AMCS has evolved from a method of stepwise escalation to heart replacement therapies (ventricular assist device, total artificial heart and/or heart transplantation) to the novel concept of bridge to "next therapy" with the primary goal of partial or complete recovery of native heart function.[7–8]

The management of patients with counter-pulsation, temporary micro-axial flow pumps and/or extracorporeal membrane oxygenation (ECMO) can be potentially compromised in centers not equipped to troubleshoot complications and guide timely transitions. The transitions are often guided by heterogeneous forms of cross-talk between centers with AMCS capabilities and a complete spectrum of heart replacement therapies, referred to as "hub and spoke" model, with the majority of expertise in durable transitions concentrated in VAD/Tx capable hubs.[9] Decisions regarding escalation of support to recovery and/or palliative care discussions are challenging and poorly described in the AMCS literature. The use of bedside hemodynamic, imaging and biochemical data usually drive these decisions but there is no clear consensus as to which metrics are most useful in guiding management beyond diagnosis of CS.[10] As we continues to evolve into an AMCS/VAD center, we would like to reflect upon the complexities of peri-shock care, by highlighting the challenges of bedside hemodynamic, biochemical/metabolic monitoring and the need for homogeneous communication and collaboration between hub and spoke providers in the evolving era of AMCS and acute cardiopulmonary care.

Once a patient arrives to the ICU in CS and/or after AMCS implantation, front-line clinicians are inundated with an overwhelming amount of clinical and hemodynamic data. This surplus of clinical metrics generates a low signal to noise ratio which we feel can complicate decision making and may lead to delays in management. Technological advances are not only found in our critical care units but also in our pockets with devices able to connect us with more providers and patients worldwide. Remote-access has opened new avenues for collaboration between colleagues, institutions and countries alike, as frequently shown through portals like ISHLT Connect. Contemporary CS management is often discussed on the phone with limited imaging and hemodynamic parameters which may be accompanied by what individual providers feel is relevant cardiovascular data. Many centers have over-simplified their approaches to a strategy of open-access transfer. How do hub and spoke providers effectively communicate the overwhelming amount of available data and guide further transitions in care? How can we timely individualize the referral/acceptance process in CS/AMCS? How can we discuss the same problem if we don't have a common language?

We believe what is required is a systematic standardization of clinically available parameters with the primary goal of identifying hemodynamic profiles. An example of our proposed necessary data sets is shown in Fig. 1. Clinical data requires prioritized standardization to distill relevant information and create not only unique hemodynamic profiles for each patient but to the underlying heart and vascular pathology and the spectral interactions of severity with circulation, coronary perfusion and end-organ function as recently described in the hemodynamic equation.[11] The concept of situational awareness in cardiac critical care has helped move from static

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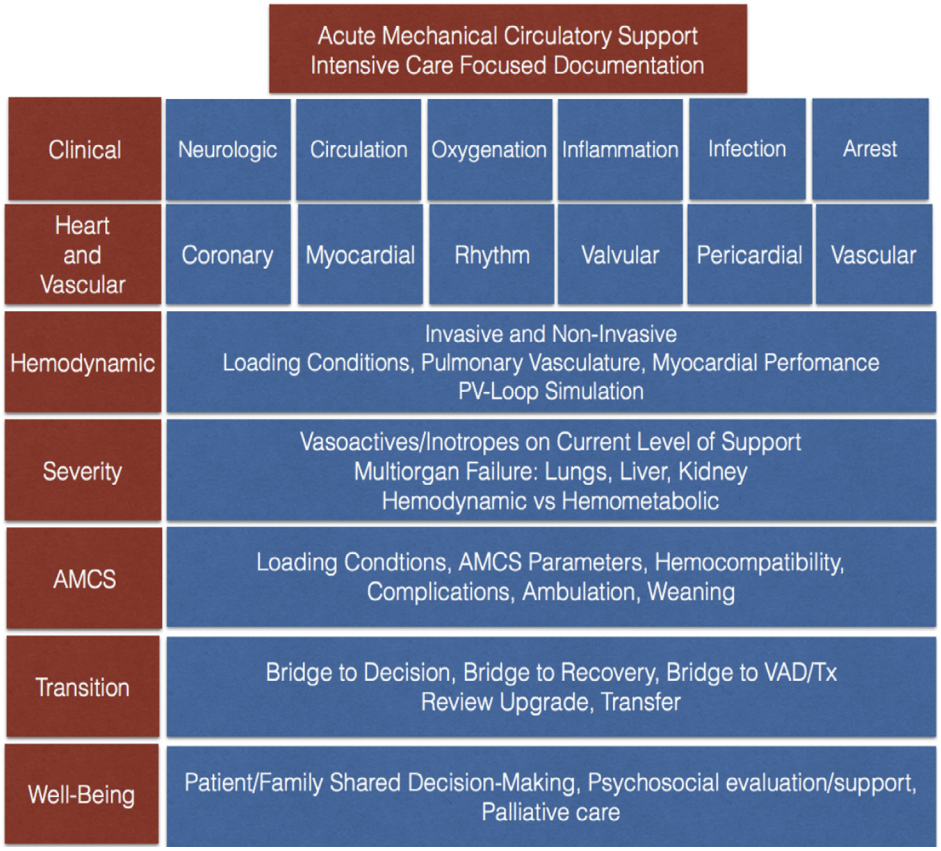

Fig. 1. Schematic of intensive care focused documentation for patients in cardiogenic shock supported with acute mechanical circulatory support.

monitoring to dynamic tracking of clinically useful data sets.[12] The application of situational awareness in AMCS/CS should focus on a framework of organized data gathering to accurately display individualized/dynamic hemodynamics parameters including simulation of pressure-volume loops.[13] This may give us a better understanding of the spectrum of severity of CS and adequately separate the disease process (hemodynamic versus hemometabolic CS) from the substrate (frailty and mobility) with the potential to impact timing and decision to next therapies as well as provide a framework for patient care and systematic clinical trial design.

Implementation of individualized pressure–volume (PV) loop simulation allows interpretation beyond static or isolated single hemodynamic values.[14,15] It also aids in conceptualizing dynamic ventricular unloading despite the absence of studies supporting its clinical validity.[16] The value of incorporating real-time dynamic PV loops to our practice can potentially remodel the language of CS care focused on preload/afterload, end-organ perfusion, liver/renal decongestion, ventricular unloading, and Right atrial (RA)-Pulmonary Arterial (PA) and/or Left Ventricular (LV)-Aortic(Ao) uncoupling. This is in contrast to the conventional isolated hemodynamic goals that lead to changes in AMCS device settings, volume management and vasodilator/inotrope support. The later interventions are often a response based on isolated values such as right atrial pressure, pulmonary artery diastolic pressure and/or cardiac index. Furthermore, dynamic

Determinants of cardiovascular function	**Measurements and calculations**
Myocardial oxygen demand	Heart rate, Infection Surveillance, Sedation
Preload	Hematocrit, Right atrial pressure
Afterload	Systemic vascular resistance, Mechanism of support device
Device function	Level of support, RPMs, Power
Myocardial function	Pulsatility, LVOT VTI on support
Mechanical Unloading	PA pulsatiliy index, RAP:PCWP, LVEDP
Well-Being	Coordinated psychosocial and palliative care evaluation for patient and caregivers

Fig. 2. Parameters with potential clinical impact on dynamic evaluation and decision-making in patients in cardiogenic shock supported with acute mechanical circulatory support.

bedside PV-Loops can help document aspects that are of critical value for decision making some of which we have outlined in Fig. 2. This systematic hemodynamic language allows individualizing the potential for myocardial recovery or the early need for a transition to a durable solution.

With new innovations in AMCS and remote access to patient care and collaboration we are faced with new challenges in how we communicate. To adapt to this new opportunity, we propose a list of useful clinical domains for better handoff amongst providers that transcends our personal practice styles and/or institutional-biases. This in turn will help tailor therapies to the patients social, hemodynamic, hemometabolic and circulatory needs. A systematic approach to patient care may also help as a common platform for future research with meaningful clinical endpoints in AMI and non-AMI CS with AMCS devices. It is our hope that through collaboration and a unified method of data gathering we can improve the quality and safety of our MCS programs.

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References

1. Stretch R, Sauer C, Yuh D, Bonde P. National trends in the utilization of short-term mechanical circulatory support incidence, outcomes, and cost analysis. *J Am Coll Cardiol*. 2014;64(14):1407–1415.
2. Kastrati A, Colleran R, Ndrepepa G. Cardiogenic shock: how long does the storm last. *J Am Coll Cardiol*. 2016;67:748–750.
3. Thiele H, Zeymer U, Neumann FJ, et al. Intraaortic balloon support for myocardial infarction with cardiogenic shock. *N Engl J Med*. 2012;367:1287–1296.
4. Ouweneel DM, Eriksen E, Sjauw KD, et al. Percutaneous mechanical circulatory support versus intra-aortic balloon pump in cardiogenic shock after acute myocardial infarction. *J Am Coll Cardiol*. 2017;69:278–287.
5. Thiele H, Akin I, Sandri M, et al. PCI strategies in patients with acute myocardial infarction and cardiogenic shock. *N Engl J Med*. 2017;377:2419–2432.
6. Rihal CS, Naidu SS, Givertz M, et al. SCAI/ACC/HFSA/STS Clinical expert consensus statement on the use of percutaneous mechanical circulatory support devices in cardiovascular care. *JACC*. 2015;65:e7–e26. 2015.
7. Lima B, Kale P, Gonzalez-Stawinski GV, et al. Effectiveness and safety of the Impella 5.0 as a bridge to cardiac transplantation or durable left ventricular assist device. *Am J Cardiology*. 2016;117:1622–1628.
8. Hall SA, Uriel N, Carey SA, et al. Use of a percutaneous temporary circulatory support device as a bridge to decision during acute decompensation of advanced heart failure. *J Heart Lung Transplant*. 2018;37:100–106.
9. van Diepen S, Katz JN, Albert NM, et al. Contemporary management of cardiogenic shock: a scientific statement from the American Heart Association. *Circulation*. 2017;136:e232–e268.
10. Kapur NK, Esposito ML, Bader Y, et al. Mechanical circulatory support devices for acute right ventricular failure. *Circulation*. 2017;136:314–326.
11. Esposito ML, Kapur NK. Acute mechanical circulatory support for cardiogenic shock: the "door to support" time. *F1000Res*. 2017;6:737.
12. Engelman D, Higgins TL, Talati R, Grimsman J. Maintaining situational awareness in a cardiac intensive care unit. *J Thorac Cardiovasc Surg*. 2014;147:110–1106.
13. Dickstein M. The Starling relationship and veno-arterial ECMO: Ventricular distension explained. *ASAIO J* 2017. http://dx.doi.org/10.1097/MAT.0000000000000660.
14. Furer A, Wessler J, Burkhoff D. Hemodynamics of cardiogenic shock. *Interv Cardiol Clin*. 2017;6:359–371.
15. Verbelen T, Burkhoff D, Kasama K, et al. Systolic and diastolic unloading by mechanical support of the acute vs the chronic pressure overloaded right ventricle. *J Heart Lung Transplant*. 2017;36:45–465.
16. Leisman S, Burkhoff D. Use of an iPad App to simulate pressure-volume loops and cardiovascular physiology. *Adv Physiol Educ*. 2017;41:415–424.

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