The Scourge of Cardiogenic Shock

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"Shock is a momentary pause in the act of death"

–John Collins Warren

Ask any clinician in cardiovascular medicine to list the biggest challenges to optimal patient management, and cardiogenic shock will likely make the top five. Cardiogenic shock (CS) affects more than 100,000 patients each year, and 30-day mortality continues to approach 50% despite improvements in critical care practices and advances in the treatment of several cardiovascular diseases. The lack of a standardized definition of CS as well as multiple presentations and causes make it difficult to diagnose, which in turn delays treatment and/or transfer to an experienced center. In the meantime, patients can quickly deteriorate and progress through increasingly severe phases.

Nonetheless, some positive developments are starting to emerge. Just last year, the Society of Cardiovascular Angiography and Interventions (SCAI) proposed a new definition and classification system for CS to enable rapid assessment, tracking of patient progression, and deployment across all clinical settings. Multiple registries are providing new insight into this complex syndrome, and the medical community is starting to consider how systems of care can be standardized so providers can diagnose CS earlier and initiate treatment or direct patients to centers that can handle the complex decision making required for these patients.

In this issue of the *Methodist DeBakey Cardiovascular Journal*, leading authorities in cardiogenic shock from Baylor University Medical Center, Cleveland Clinic, Columbia University Medical Center, the Houston Methodist DeBakey Heart & Vascular Center, Texas A&M Health Science Center, Tufts Medical Center, and The University of Texas Medical Center at Houston discuss the current state of CS, its manifestation in different cardiovascular disease settings, special challenges and barriers to care, and the progress being made to increase awareness in the medical community.

We open with a review by Drs. Daniel Burkhoff, Michael Brener, and Hannah Rosenblum that focuses on the definitions, etiologies, and advanced hemodynamic principles underlying cardiogenic shock (CS). The rising incidence of CS is fueling the development of new therapies intended to improve treatment, yet medical guidelines are unable to keep up with the pace of innovation. As a result, the medical community is left to rely on the prevailing yet outdated concept that CS is merely a result of low blood pressure and reduced cardiac output. In their review, the authors discuss a more nuanced analysis of CS that factors in the complex interactions between the ventricles and the systemic/pulmonary vasculature, the interdependence between the left and right ventricles, and the molecular and inflammatory environment that often accompanies CS.

Cardiogenic shock in the setting of acute myocardial infarction (AMI) continues to be a major cause of morbidity and mortality, which is concerning since AMI accounts for 81% of patients in CS. Also alarming is the fact that patients with ST-elevation MI (STEMI) have a 2-fold increased risk for developing CS. Dr. Navin Kapur and colleagues Katherine Thayer and Elric Zweck discuss CS in the setting of AMI/STEMI and the key elements for optimal treatment, including the integration of hemodynamic and metabolic data for diagnosis and risk stratification, early evaluation and appropriate initiation of acute mechanical circulatory support devices, and an organized algorithmic approach to decision making. They also include an overview of patient outcomes, reasons for heterogeneity in trial and registry data, and the various classifications schemes being developed that will hopefully lead to a standard CS treatment protocol.

Patients with end-stage heart failure who have failed optimal medical therapy provide a unique set of challenges because their progression to a refractory state of CS is associated with dismal outcomes. Current definitions and phenotypes of cardiogenic shock are unclear and less predictable for these patients, and their exhausted reserves make them less likely to respond to medical interventions and more likely to need temporary mechanical circulatory support. Drs. Shelley Hall and Cesar Guerrero-Miranda examine the obstacles for patients with CS due to advanced chronic heart failure–including the heterogeneity of CS (with its different phenotypes, etiologies, hemodynamics, and end-organ effects), lack of a universal definition that applies to these patients, and blunted hemodynamic response given their prolonged compensatory state–and explain the classification of CS in patients with advanced heart failure, the utility of temporary mechanical circulatory support, and the role of the CS team.

Next, Drs. Jerry Estep and Kartik Telukuntla describe the different types of acute mechanical circulatory support that are increasingly being used to manage outcomes in patients

with CS. Multiple short-term device options are available to provide left and/or right-sided support, and device selection is guided by hemodynamic support needs, operator/institutional experience, and device-specific complications and risks. The most widely used short-term device is the intra-aortic balloon pump, although more robust devices are being used with increased frequency. However, the provision of greater hemodynamic support comes with device platforms that are more complex and potentially associated with more adverse events. In this review, the authors compare and contrast the available percutaneous and surgically placed devices used in CS and discuss the associated clinical and hemodynamic data to support device use.

Cardiogenic shock is frequently complicated by multiorgan system dysfunction, which makes it one of the leading indications for admission to a cardiac intensive care unit (CICU). The presence of acute noncardiovascular illnesses such as acute kidney injury or acute respiratory failure has been associated with increased in-hospital mortality and longer length of stay in the CICU. In their review, Drs. Ju Kim, Anusha Sunkara, and Sara Varnado convey the practical considerations for management of CS in the critical care setting and discuss the clinical judgment and appropriate application of hemodynamic data needed to improve patient outcomes. Given its complexity and associated high mortality rate, the authors stress that management of CS in the CICU requires rapid yet careful investigation into its etiology, prevention and management of multiorgan system dysfunction, and a collaborative multidisciplinary approach to optimize treatment and achieve favorable outcomes.

From here, under my guidance, Dr. Benjamin Salgado provides a case-based report to illustrate real-life scenarios using the pathophysiologic and technical principles delineated in this issue. Cardiogenic shock is a complex syndrome that may present as an acute or acute over chronic process, and while initial compensatory physiologic mechanisms allow transient stabilization of hemodynamics, these mechanisms become pathological over time and lead to disease progression. Therefore, management of CS requires timely and proficient decision making to optimize care. Through two patient scenarios and the use of pressure-volume loop simulations from an online software, we describe the challenges of early identification of CS, explain the difficulty in selecting the most appropriate mechanical circulatory device considering the impact of preload, afterload, and contractility on the circulatory system, and stress how treatment choices should be based on a thorough understanding of CS physiology.

Finally, Drs. Biswajit Kar, Maria Patarroyo Aponte, and Carlos Manrique wrap up this issue with a review on systems of care in CS. Although CS continues to be a significant challenge, there is still much debate as to the best classification system and treatment mechanisms. As interventions and technologies improve, systems of care for CS must evolve as well. A regionalized system of care that includes hub-and-spoke institutions should have standardized protocols for early recognition and appropriate management of patients with CS and an efficient transfer plan between institutions. Systems that include multidisciplinary teams have shown improvement of short- and long-term outcomes, including quality of life and survival. The authors relay the limitations and barriers to implementing systems of care for CS, describe the current treatment models, and define specific characteristics of the ideal system of care for this patient population.

We invite readers to the journal website for an extra online-only review highlighting the benefits of a team approach to CS in perioperative and intraoperative settings. Between 2% and 6% of patients who undergo cardiac surgery develop CS, and when it occurs in a peri- or intraoperative environment, factors such as surgery, anesthesia, and post-surgical physiological issues can have a negative impact on patient outcomes. Since patient needs—from medications to mechanical support to palliative care—often escalate during CS, this disease demands a multidisciplinary approach that encompasses all aspects of medical delivery. Dr. Faisal Masud, nurse practitioner Gaurav Gheewala, and their colleagues discuss various management strategies for CS from an anesthesiology, surgery, and critical care perspective and cite studies indicating how a multidisciplinary team approach to CS results in earlier diagnosis and treatment and improved patient outcomes. You can read this online review at https://journal.houstonmethodist.org.

We hope this issue provides some new insights about caring for patients in cardiogenic shock and that you gain a better understanding of what is needed to facilitate risk stratification, guide therapeutic choices, and optimize outcomes in this vulnerable population. For further discussion and CME opportunities, I invite you to visit the journal's website at http://journal.houstonmethodist.org, where you can log in and use the “Dialogue with Authors” link to have an open Q&A with the authors of this issue.