Medicina Intensiva 47 (2023) 406–410

medicina intensiva

http://www.medintensiva.org/en/

POINT OF VIEW

Cardiogenic shock code 2023, towards a quality multidisciplinary organization

Código *shock* cardiogénico 2023, hacia una organización multidisciplinaria de calidad

Luis Martin-Villen[a,*], **Manuel Martínez-Sellés**[b], **José Francisco Diaz-Fernandez**[c], **Lluis Zapata-Fenor**[d]

[a] *Servicio de Medicina Intensiva, Hospital Universitario Virgen del Rocío, Sevilla, Spain*
[b] *Servicio de Cardiología, Hospital Universitario Gregorio Marañon, CIBERCV, Universidad Europea, Universidad Complutense, Madrid, Spain*
[c] *Servicio de Cardiología, Hospital Universitario Virgen del Rocío, Sevilla, Spain*
[d] *Servicio de Medicina Intensiva, Hospital de la Santa Creu i Sant Pau, Universitat Autònoma de Barcelona, Barcelona, Spain*

Received 13 February 2023; accepted 22 March 2023
Available online 10 May 2023

Introduction

Heart failure is a worldwide issue due to its prevalence and because it takes over a huge number of resources. Also, population aging and the improved prognosis of other acute cardiovascular processes anticipate higher incidence rates within the next few decades.[1] Acute heart failure (AHF) is a life-threatening disease characterized by a lack of balanced between the supply and demand of oxygen due to heart damage. In addition, it has a rapid onset that requires emergency assessment and treatment.[2] Cardiogenic shock (CS)—where cellular hypoxia can trigger multi-organ failure—is the most serious type of AHF. A total of 5 different stages have been easily established through physical examination, biochemical markers (lactate and degree of metabolic acidosis), and hemodynamic parameters associated with prognosis: A (patients at risk of CS), B (beginning CS), C (classic CS), D (deteriorating/doom CS), and E (extremis CS).[3] The process of CS deterioration can be reversible if identified early and the proper measures are implemented to control the triggering causes, establish mechanical circulatory support (MCS) that restores tissue perfusion, and replace failed organs.

The management of CS is complex and has different stages: identification and classification, hemodynamic assessment and early stabilization, cardiac procedures (whether coronary or structural), if necessary, indication of early implantation of circulatory support in cases of refractory shock, specialized intensive care focused on multi-organ support, and finally, long-term outflow tracts. Therefore, throughout 2022, different scientific societies collaborated to draft an expert consensus document to pro-

DOI of original article: https://doi.org/10.1016/j.medin.2023.03.006
* Corresponding author.
E-mail address: luis.martin.villen.sspa@juntadeandalucia.es (L. Martin-Villen).

https://doi.org/10.1016/j.medine.2023.04.001

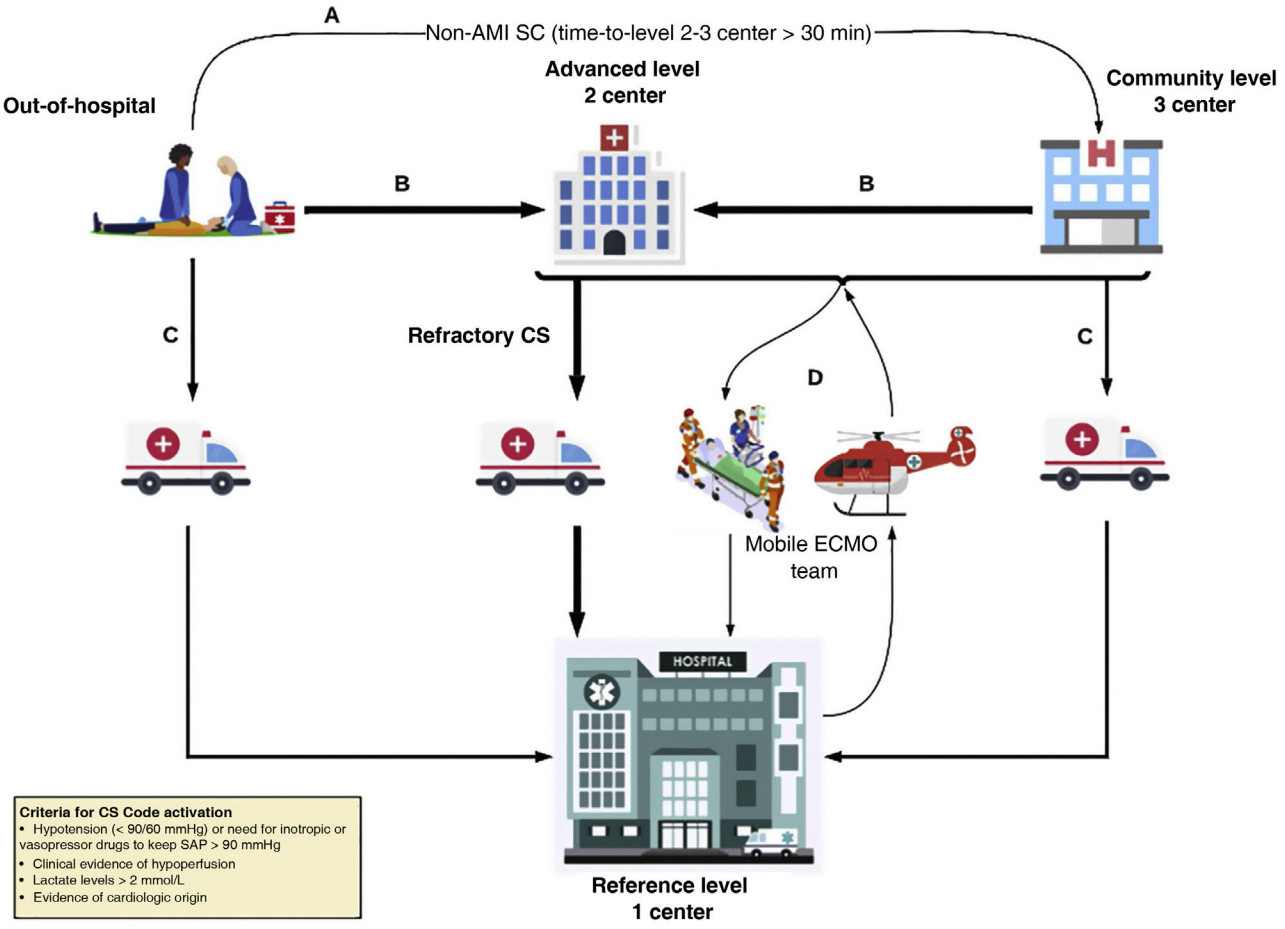

Figure 1 Flow of patients from the Cardiogenic Shock Care Network.
Adapted from M. Martínez-Sellés et al.[4] **A:** to achieve the early stabilization of a patient with CS not associated with an acute myocardial infarction (AMI) diagnosed outside the hospital, the patient can be transferred to the closest level 3 hospital available if transfer to a level 1–2 center exceeds 30 min compared to the transfer to such level 3. **B:** a patient diagnosed with CS outside the hospital setting or who remains at a level 3 center should be transferred to a level 1 or 2 center depending on transfer times, especially in the acute coronary syndrome setting. **C:** a patient with CS diagnosed outside the hospital setting or who remains at a level 3 hospital can be transferred to a level 1 center if the need for high-complexity care is anticipated. **D:** activation of the ECMO team. A mobile unit can be activated from the level 1 center towards the different reference centers available (level 2 and 3 centers) if high-complexity mechanical circulatory assist device implantation is required to secure a safe transfer. CS, cardiogenic shock; ECMO, extracorporeal membrane oxygenation; SAP, systolic arterial pressure.

pose a multidisciplinary organization to allow rapid and proper care in the form of a code.[4]

Justification

Although the prevalence of CS varies depending on the definition, clinical care setting, and the era of data mining, it represents 14%–16% of the patients admitted to the intensive care unit (UCI) due to AHF.[5] Despite the advances made on its management, the in-hospital mortality rate is high (somewhere between 30% and 60% depending on the underlying etiology), which amounts to over half of the deaths reported within the first 24 h after admission. This high mortality rate is determined by both non-modifiable factors like the patient's age or his underlying disease, and modifiable factors like precocity in case identification, recovery of tissue perfusion, and access to MCS.[2]

The use of MCS is a highly specialized process that requires resources in critical care units not available in all the centers assisting acute patients, thus making it necessary to establish in-hospital coordination and coordination criteria to facilitate proper patient referral and improve the patient's prognosis.[6–10]

Therefore, the management of CS meets the code criteria based on its incidence rate, severity, and need for standardization both regarding in-hospital management and coordination (Fig. 1).

Proposal

The CS code is born to facilitate the proper multidisciplinary care and promote standardized and ongoing healthcare by using proper resources early in a context that assigns a certain level of care to a patient's clinical situation while taking

Table 1 Characteristics of the hospitals from the Cardiogenic Shock Care Network based on their level of care.

	Function	Equipment
Level 3 or community hospital	Detection of CS Early care	Vasoactive drugs Hemodynamic monitorization Diagnosis Advanced life support
Level 2 or advanced hospital	Detection of CS Early care Advanced CS care	Level 3 Primary PCI Short-term MCS (VA-ECMO, IABP, Impella®) Cardiac surgery*
Level 1 or reference hospital	Detection of CS Early care Advanced CS care CS team Transportation Definitive treatment	Level 2 Transportation equipment Mid-long-term duration VAD Heart transplant

Adapted from M. Martínez-Sellés et al.[4] CS, cardiogenic shock; IABP, intra-aortic balloon pump; MCS, mechanical circulatory support; PCI, percutaneous coronary intervention; VA-ECMO, venoarterial extracorporeal membrane oxygenation; VAD, ventricular assist device.
* Depending on the geographic distribution and availability of the different centers, advanced centers without cardiac surgery but with PCI capabilities could be available.

into consideration the time factor. Therefore, a network care model known as ''Hub and Spoke'' has been proposed to administer treatment based on the patients' needs in a timely manner and in the most adequate center while taking into consideration the geographic characteristics of each center and health region.

Therefore, it is essential to identify the characteristics of the hospitals based on their level of care (Table 1). Level 3 hospitals play an essential role regarding identification where index assessments by a doctor specialized in critical care facilitate the activation of the CS Code. Level 2 PCI-capable hospitals also capable of implanting venoarterial extracorporeal membrane oxygenation (VA-ECMO)-type short-term MCS—whether surgical or percutaneous based on the availability of heart surgery—will be receiving patients transferred from level 3 centers. Finally, level 1 hospitals have a heart team coordinating the entire process with accredited experience in the use of short-, mid-, and long-term MCS and/or heart transplant (Table 2).

A key element of this process is inter-center transfers. Therefore, the need for transferring different teams and equipment to implant MCSs in level 3 or 2 centers should be taken into consideration, as well as the need for further transfers to higher level hospitals.[11] These cannulation and transfer teams should become adapted to the regional needs, be available on a 24/7 basis, and experienced and skilled enough transferring and managing the possible complications than can occur.

The CS Code should be a program focused on continuous improvement. Therefore, easy-to-measure process indicators like the in-hospital mortality rate, the number of patients with CS due to acute coronary syndrome on the emergency coronary angiography performed (<120 min), and participation in the RENACER registry of MCS in Spain should be established.[4]

Table 2 Composition of the heart team managing cardiogenic shocks, functions, and targets.

Members	Functions	Common targets
Emergency medical services	First contact with the patient if he/she is still not hospitalized	1. Guarantee fast diagnosis
Emergency doctors and nurses	Risk stratification and early approach	2. Identify specific phenotype
In-hospital intensivists	Decision regarding the receiving center	3. Assignment to the appropriate care level
	Center transfer with level 1 or 2 support	4. Decision-making on interventions and MCS
Specialist savvy in coronary care (*shock doc*) and critical care nursing staff	Process coordination	5. Recognize uselessness and adopt palliative measures
	Identification, stratification, and diagnosis	6. Identify patients eligible for clinical trials

Table 2 (*Continued*)

Members	Functions	Common targets
	Medical therapy	
	Invasive hemodynamic monitorization	
	Follow-up, planning, and early decision of MCS	
	Percutaneous implantation of short-term MCS	
	Multi-organ failure support	
	Follow-up after intervention and postoperative	
	Neurological assessment	
	Rehabilitation and nutrition	
	Life support adequation	
	End-of-life/Palliative care	
	Organ donation	
Expert cardiologist in HF and heart transplants	Medical therapy	
	Decision to proceed with long-term MCS	
	Indications and contraindications of heart transplant	
Interventional cardiologist and nurse	Structural heart procedure	
	Early decision of MCS	
	Short-term MCS percutaneous implantation	
Surgical block (cardiac surgery, vascular, anesthesiology, perfusionist, surgical nursing team)	Short-and-mid-term MCS percutaneous implantation	
	Heart transplant/long-term VAD	
	MCS device control during implantation, exchange or transfer	

Adapted from M. Martínez-Sellés et al.[4] MCS, mechanical circulatory support; VAD, ventricular assist device.

Reflection

The CS Code poses an organizational challenge for the entire healthcare system opening a new care circuit that will require changes in both the flow of patients and funding. Its implementation can find obstacles in all the aforementioned steps. Placing the patient at the center of care for the development of the code, the benefit of multidisciplinary care grouped into expert centers exceeds by far the reservations this proposal can trigger like incomprehension from unselected hospital to host coordination teams or the need for funding, structural, and human resources.

The development of regional protocols with institutional support and ongoing training with hospital participation across all levels of the transportation and system network will be the key for success, and the efficient and responsible use of this resource.

Conflicts of interest

None reported.

Funding

None whatsoever.

References

1. Ambrosy AP, Fonarow GC, Butler J, Chioncel O, Greene SJ, Vaduganathan M, et al. The global health and economic burden of hospitalizations for heart failure: lessons learned from hospitalized heart failure registries. J Am Coll Cardiol. 2014;63:1123–33, http://dx.doi.org/10.1016/J.JACC.2013.11.053.
2. Chioncel O, Parissis J, Mebazaa A, Thiele H, Desch S, Bauersachs J, et al. Epidemiology, pathophysiology and contemporary management of cardiogenic shock - a position statement from the Heart Failure Association of the European Society of Cardiology. Eur J Heart Fail. 2020;22:1315–41, http://dx.doi.org/10.1002/EJHF.1922.
3. Naidu SS, Baran DA, Jentzer JC, Hollenberg SM, van Diepen S, Basir MB, et al. SCAI SHOCK Stage Classification Expert Consensus Update: A Review and Incorporation of Validation Studies: this statement was endorsed by the American College of Cardiology (ACC), American College of Emergency Physicians (ACEP), American Heart Association (AHA), European Society of Cardiology (ESC) Association for Acute Cardiovascular Care (ACVC), International Society for Heart and Lung Transplantation (ISHLT), Society of Critical Care Medicine (SCCM), and Society of Thoracic Surgeons (STS) in December 2021. J Am Coll Cardiol. 2022;79:933–46, http://dx.doi.org/10.1016/J.JACC.2022.01.018.
4. Martínez-Sellés M, Hernández-Pérez FJ, Uribarri A, Martín Villén L, Zapata L, Alonso JJ, et al. Cardiogenic shock code 2023. Expert document for a multidisciplinary organization that

allows quality care. Rev Esp Cardiol (Engl Ed). 2022;76:261–9, http://dx.doi.org/10.1016/J.REC.2022.10.014.
5. Zapata L, Guía C, Gómez R, García-Paredes T, Colinas L, Portugal-Rodriguez E, et al. Clinical presentation and outcomes of acute heart failure in the critically ill patient: a prospective, observational, multicentre study. Med Intensiva. 2022;47:221–31, http://dx.doi.org/10.1016/j.medin.2022.03.009.
6. Basir MB, Kapur NK, Patel K, Salam MA, Schreiber T, Kaki A, et al. Improved Outcomes Associated with the use of Shock Protocols: updates from the National Cardiogenic Shock Initiative. Catheter Cardiovasc Interv. 2019;93:1173–83, http://dx.doi.org/10.1002/CCD.28307.
7. Lee F, Hutson JH, Boodhwani M, McDonald B, So D, de Roock S, et al. Multidisciplinary Code Shock Team in Cardiogenic Shock: a Canadian Centre Experience. CJC Open. 2020;2:249–57, http://dx.doi.org/10.1016/J.CJCO.2020.03.009.
8. Tehrani BN, Truesdell AG, Psotka MA, Rosner C, Singh R, Sinha SS, et al. A standardized and comprehensive approach to the management of cardiogenic shock. JACC Heart Fail. 2020;8:879–91, http://dx.doi.org/10.1016/J.JCHF.2020.09.005.
9. Taleb I, Koliopoulou AG, Tandar A, Mckellar SH, Tonna JE, Nativi-Nicolau J, et al. Shock team approach in refractory cardiogenic shock requiring short-term mechanical circulatory support: a proof of concept. Circulation. 2019;140:98–100, http://dx.doi.org/10.1161/CIRCULATIONAHA.119.040654.
10. Barnett CF, Brusca SB, Hanff TC, Blumer V, Kaliff A, Kanwar M. Management of cardiogenic shock unrelated to acute myocardial infarction. Can J Cardiol. 2023;39:406–19, http://dx.doi.org/10.1016/j.cjca.2023.01.023.
11. Argudo E, Hernández-Tejedor A, Belda Hofheinz S, Fuset MP, Sanchez Galindo A, Burgueño P, et al. Spanish Society of Intensive and Critical Care Medicine and Coronary Units (SEMICYUC) and the Spanish Society of Pediatric Intensive Care (SECIP) consensus recommendations for ECMO transport. Med Intensiva. 2022;46:446–54, http://dx.doi.org/10.1016/J.MEDINE.2022.06.005.