Time for a rethink in cardiogenic shock: the shock to survival framework document

Abstract

Cardiogenic shock remains a time-critical, complex syndrome that continues to present challenges to clinicians and healthcare systems. Despite advances in the fields of cardiovascular and critical care medicine, mortality remains high. This article summarises the recent shock to survival document, which outlined the current and ideal future state of cardiogenic shock care nationally to improve patient outcomes. Shock to survival emphasises the need for education and training in the early recognition of the hypoperfusion that is pathognomomic of cardiogenic shock. Improved provision of focused cardiac ultrasound is essential to confirm a cardiac cause. Early identification of the patient with cardiogenic shock should be supported by access to defined pathways of care, including specialist shock centres and multiprofessional teams with domain expertise and the capability to manage the myriad of causative aetiologies. Given the absence of high-quality data to inform practice nationally, robust datasets are an unmet need to inform best practice, guide design of clinical services and pathways and drive innovation through research and clinical trials.

Key words: Acute myocardial infarction; Cardiogenic shock; Hypoperfusion; NEWS-2; Shock teams; Shock networks; Variation

Submitted: 17 April 2023; accepted following double-blind peer review: 25 April 2023

Marie Buckel[1]

Alastair G Proudfoot[2,3]

Author details can be found at the end of this article

Correspondence to:
Alastair G Proudfoot;
alastair.proudfoot1@nhs.net

Cardiogenic shock is a syndrome of organ and tissue hypoperfusion, primarily as a result of cardiac dysfunction. It can be ischaemic (myocardial infarction) or non-ischaemic (eg myocarditis or peripartum) in aetiology, and present acutely or de novo, or as a deterioration of pre-existing heart failure. Despite two decades of clinical research, in-hospital mortality remains high at 30–50% and the only current evidence-based intervention is early coronary revascularisation of the culprit vessel in patients with cardiogenic shock as a result of acute myocardial infarction (Hochman et al, 1999; Thiele et al, 2017).

The incidence of cardiogenic shock in the UK is poorly understood, but data from London heart attack centres suggest a temporally rising incidence, increasing from 7% in 2005 to 13% in 2015 of all cases of percutaneous coronary intervention (Rathod et al, 2018). Mortality in this cohort ranged from 45% to 70% across the study period in a population with a median age of 65 years. There has been an increase in critical care admissions of non-ischaemic aetiologies including either de-novo heart failure syndromes and decompensated heart failure (Berg et al, 2019; Jentzer et al, 2021). This means that patients with cardiogenic shock can present across the hospital from emergency departments to obstetric units, where not all clinicians and escalation pathways are primed to recognise and manage the heterogenous presentations and acuity of cardiogenic shock in a climate where hypotension is often sepsis until proven otherwise.

These factors, coupled with high variation in care nationally, including access to specialist care, likely contribute to poor outcomes. In recognition of these challenges, and to align NHS services with both international guidance (van Diepen et al, 2017; McDonagh et al, 2021) and the recommendations of the Cardiology Getting It Right First Time (GIRFT) report (Clarke and Ray, 2021), the multisociety UK Cardiogenic Shock Working Group formed to produce a framework which outlines the key steps to improve clinical outcomes and minimise variations in care (Figure 1) (UK Cardiogenic Shock Working Group, 2022). This article summarises the document's key recommendations from recognition through to escalation to specialised cardiogenic shock teams and the formation of regional cardiogenic shock networks.

How to cite this article:
Buckel M, Proudfoot AG. Time for a rethink in cardiogenic shock: the shock to survival framework document. Br J Hosp Med. 2023. https://doi.org/10.12968/hmed.2023.0139

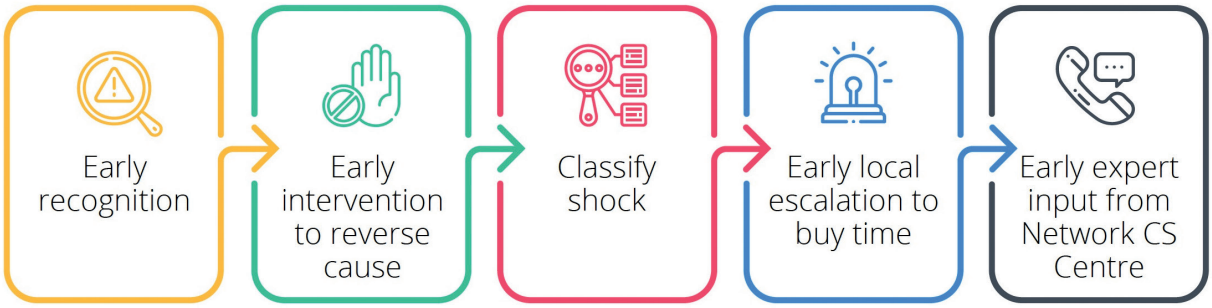

Figure 1. Key steps to survival in the management and escalation of cardiogenic shock (CS).

Early recognition

Early, reliable identification of hypoperfusion by all healthcare staff working in acute care areas, and subsequent escalation of patients with cardiogenic shock to specialists in both cardiogenic shock and the management of critical illness, will be the most impactful and cost-effective intervention. There is currently no validated early warning scoring system for the identification of patients deteriorating secondary to cardiogenic shock. The UK Cardiogenic Shock Working Group recommended the use of the National Early Warning Score (NEWS)-2 coupled with clinical and biochemical metrics of hypoperfusion to identify patients with emerging or established cardiogenic shock. NEWS-2 is commonly used, easy to implement and is part of a wider response to deterioration embedded in UK hospitals (Royal College of Physicians, 2017). Table 1 highlights additional features suggesting a diagnosis of cardiogenic shock.

Early diagnostics and intervention to reverse the cause

Identification of the patient with potential cardiogenic shock using NEWS-2 should be supported by laboratory testing and imaging, as well as an immediate electrocardiogram to exclude acute myocardial infarction as the causative aetiology. Clinical hypoperfusion should be confirmed biochemically, with evidence of perturbations of renal and liver function tests as well as quantification of serum lactate levels (arterial or venous), which has prognostic significance and can be used as a metric of therapeutic success (Marbach et al, 2022; Naidu et al, 2022). Focused cardiac ultrasound should follow urgently to support or refute the clinical suspicion of cardiac dysfunction and identify pathologies with a potentially reversible aetiology, for example pericardial tamponade or structural (valvular) heart disease.

Despite it being a core recommendation of the cardiology GIRFT report (Clarke and Ray, 2021), the writing group recognised that the robust provision of 24/7 echocardiography remains challenging. As educators, colleges and societies explore mechanisms to democratise training in echocardiography, while ensuring the requisite governance structures are embedded, the document recommended that the cadre of specialties with focused cardiac ultrasound training across the hospital is used to support out-of-hours echocardiography for the deteriorating patient with shock. Comprehensive imaging can

Table 1. Warning signs of cardiogenic shock for the general physician
National Early Warning Score (NEWS)-2 of ≥5 PLUS any of the following:
Existing or new cardiac pathology, including heart rhythm abnormalities
Clinical signs of hypoperfusion, particularly cold or mottled extremities
A shock state where the cause is unclear or does not respond to initial management
Elevated lactate levels (venous or arterial)
A narrow pulse pressure

follow, in-hours, and shock networks should explore centralised (expert) review of both emergency and elective imaging using data-sharing capabilities.

Society for Cardiovascular Angiography and Interventions classification

The UK Cardiogenic Shock Working Group recommended the adoption of the Society for Cardiovascular Angiography and Interventions shock stages (Baran et al, 2019) to classify and describe cardiogenic shock from 'at-risk' through to 'extremis' (Figure 2). This simple framework provides a common language by which the severity of cardiogenic shock and its response to intervention(s) can be articulated and monitored. Crucially, the association of this staging with an incremental increase in mortality has been validated across a heterogeneous group of patients with cardiogenic shock (Baran et al, 2020; Naidu et al, 2022). This emphasises the time-critical nature of early classification, triage and intervention with referral to shock centres (see below) in Society for Cardiovascular Angiography and Interventions stages B to E. The use of a single classification system will additionally support benchmarking and clinical research.

Early input from the regional cardiogenic shock multidisciplinary team

Multidisciplinary care planning is well established in elective cardiac care via the 'heart team'. Recognising that cardiogenic shock is a complex, time-sensitive syndrome with a paucity of high-quality evidence to guide practice, the role of the 'shock team' to support real-time decision making in patients with cardiogenic shock has evolved and translated into improved survival in observational studies (Tehrani et al, 2018; Papolos et al, 2021). Based at regional shock centres (see below), shock teams are available 24/7 via a single point of contact, and variably comprise at least an interventional cardiologist, heart failure cardiologist and cardiac intensivist. Their purpose is to bring expertise in cardiogenic shock to the patient's bedside to support efficient, optimal care planning, including transfer of patients to the regional shock centre for specialist cardiac intensive care and access to all cardiology sub-specialty expertise.

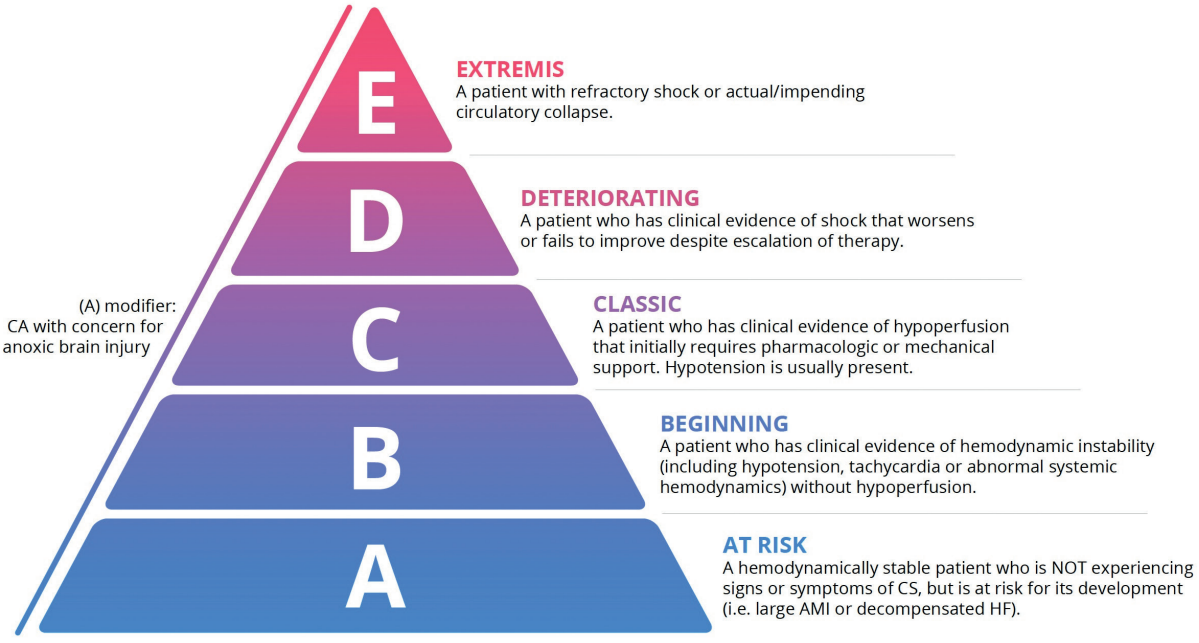

Figure 2. Society for Cardiovascular Angiography and Interventions classification SHOCK classification pyramid. AMI = acute myocardial infarction, CA = cardiac arrest, CS = cardiogenic shock, HF = heart failure. From Naidu et al (2022).

Cardiogenic shock centres at the centre of a network

Given the complexity of cardiogenic shock, coupled with the use of specialist monitoring (pulmonary artery catheters, advanced imaging) and mechanical circulatory support technologies, dedicated training and experience across medical, nursing and allied health professional teams is needed to maintain competency in delivering safe and effective care. Further, in line with other life-threatening presentations, there is a relationship between the volume of cases of cardiogenic shock treated and the outcomes (Shaefi et al, 2015). The document therefore recommended the development of high-volume cardiogenic 'shock centres' where the sickest patients with cardiogenic shock would be transferred and cohorted.

Given the only evidence-based intervention in cardiogenic shock currently is emergent revascularisation in cardiogenic shock resulting from acute myocardial infarction, provision of 24/7 capability for coronary revascularisation (percutaneous or surgical) is vital for any shock centre. In addition, shock centres would have all the capabilities to manage and support the complexity of cardiogenic shock, including 24/7 access to advanced haemodynamic monitoring, comprehensive cardiac imaging and mechanical circulatory support, as well as access to allied specialties including but not limited to vascular surgery, interventional radiology and neurology. In recognition of the high mortality of cardiogenic shock, palliative care services should be embedded within any shock service and centre to support the needs of both patients and families.

Shock centres would be responsible for provision of the 24/7 shock team as well as network governance, with a focus on education and training in the identification and escalation of cardiogenic shock across referring hospitals. Given the expertise already established in the six national advanced heart failure centres, many of these will also function as shock centres. However, one challenge is that capacity at advanced heart failure centres is limited and needs to be maintained for all patients eligible for heart transplantation. One model which may allow capacity to be maintained is a close working relationship between shock centres and supra-regional advanced heart failure centres, whereby all patients eligible for cardiac transplantation are discussed, and if such patients cannot be immediately transferred to an advanced heart failure centre, then shock centres may should be able to provide temporary mechanical circulatory support as a stabilising measure. The geographical distribution of shock centres beyond advanced heart failure centres would be defined by patient need, with equity of access being a central tenet. Given the coupling of shock centres with revascularisation capabilities, it makes sense for this to follow the existing geography of national heart attack and cardiac surgical centres. Further, given the overlap of cardiogenic shock with out-of-hospital cardiac arrest, there may be value in co-locating these services regionally.

Development of cardiogenic shock networks

Network-based care has improved outcomes in other acute care conditions and is a further recommendation of the cardiology GIRFT report. In accordance with international guidance (van Diepen et al, 2017; McDonagh et al, 2021), shock to survival recommended the development of regional shock networks with clear pathways for referral into regional shock centres from referral centres within a defined geographical area (Figure 3). Shock pathways would sit alongside existing cardiac pathways to support the sickest patients with cardiogenic shock of all aetiologies. Regional shock centres would hold responsibility for the development, distribution and iteration of network standard operating procedures and protocols to ensure homogeneity of practice and equity of access for referrers and patients across the network. This would be measured through network-based audit and quality improvement activities in collaboration with referring centres.

While escalation protocols would be designed to identify patients early in their cardiogenic shock trajectory to allow stabilisation, clearly some patients with cardiogenic shock either deteriorate in the face of optimal medical management or present in extremis. Transfer of patients who are unstable and critically unwell across networks facilitated by regional critical care transport services is now routine following the COVID-19 pandemic. Society for Cardiovascular Angiography and Interventions staging combined with clinical assessment should be used to triage the urgency of transfer and the risk of deterioration during transfer. The

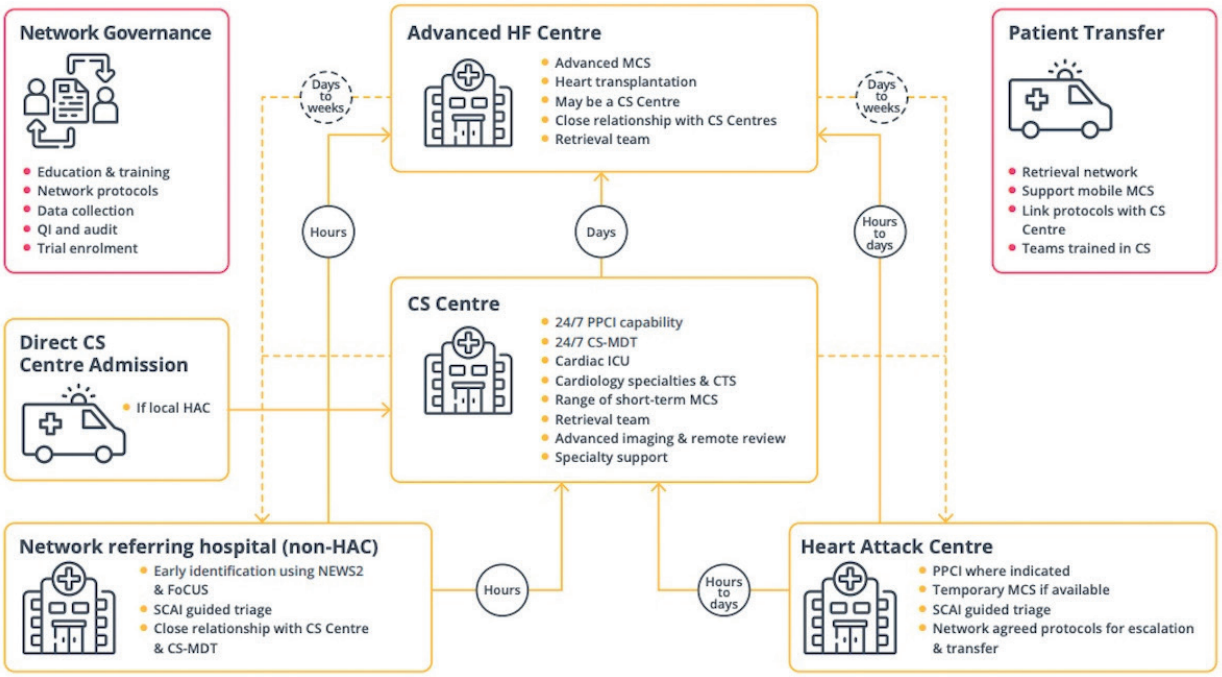

Figure 3. Structure and governance of a cardiogenic shock network. Patients are transferred either to a cardiogenic shock centre or to an advanced heart failure centre, depending on the cause of their cardiogenic shock, with a suggested timeline of both referral and repatriation. Where the local heart attack centre (HAC) is also a cardiogenic shock centre, patients may be transferred directly by ambulance services for primary percutaneous coronary intervention. CS = cardiogenic shock; CTS = cardiothoracic surgery; FoCUS = focused cardiac ultrasound; HF = heart failure; ICU = intensive care unit; MCS= mechanical circulatory support; MDT = multidisciplinary team; NEWS2 = National Early Warning Score; PPCI = primary percutaneous coronary intervention; QI = quality improvement; SCAI = Society for Cardiovascular Angiography and Interventions.

decision to transfer the most unwell patients with cardiogenic shock should balance the risk posed to the patient of the transfer with the benefits of receiving specialist care and should be informed by discussions between referrers and the regional shock team. Retrieval and transfer of patients receiving mechanical circulatory support is feasible, but requires highly specialised medical, perfusion and nursing expertise (Ali et al, 2020). The provision of mobile mechanical circulatory support should be determined and governed by the regional shock centre.

The role of mechanical circulatory support

Despite a lack of high-quality randomised trial evidence supporting its use, short-term mechanical circulatory support will continue to be an essential support modality for the sickest patients with cardiogenic shock in the UK. Aside from bridge-to-transplantation, mechanical circulatory support activity in the UK is not commissioned, but is offered by select centres nationally at local cost. It is estimated that at least 300 patients are supported with short-term mechanical circulatory support for cardiogenic shock per annum in the UK. The UK's use of mechanical circulatory support is not currently reliably captured through national audits, nor are there any national guidelines to inform patient selection. To better understand patient selection, patient outcomes and resource use, shock to survival recommended that specialist commissioning groups explore options for reimbursement of mechanical circulatory support linked to submission of patient data. Ongoing funding and patient selection criteria should be informed by the results of pending clinical trials combined with national outcome data.

Data and research to drive change

High-quality data are fundamental for (re-)designing services and improving patient outcomes. Data science has become a focus within Public Health England and nationally

in health research, with the establishment of Health Data Research UK. National audits, including the Intensive Care National Audit and Research Centre Case Mix Programme Database and the National Cardiac Audit Programme run by the National Institute for Cardiovascular Outcomes Research, capture patients with cardiogenic shock. However, neither in isolation is equipped to provide the granularity to adequately describe patient outcomes, variation in care across the patient pathway and all aetiologies of cardiogenic shock, specifically those patients with non-ischaemic cardiogenic shock. The value of dataset linkage has been highlighted by the LAUNCHES QI project (Taylor et al, 2021) and British Heart Foundation Data Science Centre (Wood et al, 2021) during the COVID-19 pandemic. Cardiogenic shock presents an excellent example of where data linkage, combined with additional data elements around mechanical circulatory support, should be used to understand outcomes across the patient pathway, identify variation and inequities in clinical outcomes, and define resource use.

Over the last 20 years, only 13 major randomised controlled trials have been published in cardiogenic shock with enrolment modestly ranging from 40 to 706 patients (Thiele et al, 2019). There remain significant knowledge–treatment gaps (Samsky et al, 2020; Arrigo et al, 2021). Despite a rich history in cardiovascular science and cardiovascular clinical trials, no prior trials of cardiogenic shock have been completed in the UK, and cardiogenic shock is not a current priority within any of the major funding bodies, including the British Heart Foundation. There is a significant opportunity for UK cardiovascular science and clinical trialists to engage with cardiogenic shock from a translational science and clinical trial perspective.

Conclusions

Uncertainties remain regarding the optimal management of cardiogenic shock. What is clear is that mortality remains high, likely in part because of a lack of awareness and delayed escalation, coupled with variation in care and access to specialist care. This creates opportunities to improve practice, resolve disparities and improve survival through the development of regional cardiogenic shock teams, centres and networks to homogenise practice and support patients and referrers. Adopting a systematic and regionalised approach to cardiogenic shock care, such as that proposed by Shock to Survival, will not require complex change but will require investment at a time of fiscal strain. The most immediate, and cost-effective intervention should be to bring cardiogenic shock to the forefront of clinicians' minds when managing the patient who is deteriorating and has evidence of hypoperfusion or is refractory to initial stabilising measures.

Author details

[1]Pan-London Intensive Care Medicine Training Programme, London, UK

[2]Perioperative Medicine Department, Barts Heart Centre, St Bartholomew's Hospital, London, UK

[3]Critical Care and Perioperative Medicine Group, Queen Mary University of London, London, UK

Conflicts of interest

The authors declare that there are no conflicts of interest.

Acknowledgements

Figures 1 and 3 are reproduced from UK Cardiogenic Shock Working Group (2022) and Figure 2 is reproduced from Naidu et al (2022).

References

Ali JM, Vuylsteke A, Fowles J-A et al. Transfer of patients with cardiogenic shock using veno-arterial extracorporeal membrane oxygenation. J Cardiothorac Vasc Anesth. 2020;34(2):374–382. https://doi.org/10.1053/j.jvca.2019.05.012

Arrigo M, Price S, Baran DA et al. Optimising clinical trials in acute myocardial infarction complicated by cardiogenic shock: a statement from the 2020 Critical Care Clinical Trialists Workshop. Lancet Respir Med. 2021;9(10):1192–1202. https://doi.org/10.1016/S2213-2600(21)00172-7

Key points

- Cardiogenic shock is a time-critical, complex syndrome of organ and tissue hypoperfusion primarily caused by cardiac dysfunction, associated with a high mortality rate.
- Early recognition using a NEWS-2 score of ≥5 coupled with clinical evidence of cardiac pathology, hypoperfusion and/or a shocked state without explanation or response to treatment is suggestive of the diagnosis.
- Focused cardiac ultrasound should be available 24/7 to support the diagnosis and management of cardiogenic shock.
- Severity should be graded by the Society for Cardiovascular Angiography and Interventions classification to guide patient acuity and expediency of discussion with and transfer to regional shock centres.
- Specialist cardiogenic shock centres, providing 24/7 access to multidisciplinary 'shock teams', should support a network of referring hospitals to allow standardisation of care and equity of access to specialist interventions.
- Enhanced and linked data collection is needed to inform and drive service re-design and better understand clinical outcomes and resource utilisation.

Baran DA, Grines CL, Bailey S et al. SCAI clinical expert consensus statement on the classification of cardiogenic shock: This document was endorsed by the American College of Cardiology (ACC), the American Heart Association (AHA), the Society of Critical Care Medicine (SCCM), and the Society of Thoracic Surgeons (STS) in April 2019. Catheter Cardiovasc Interv. 2019;94(1):29-37. https://doi.org/10.1002/ccd.28329

Baran DA, Long A, Badiye AP et al. Prospective validation of the SCAI shock classification: single center analysis. Catheter Cardiovasc Intervent. 2020;96(7):1339–1347. https://doi.org/10.1002/ccd.29319

Berg DD, Bohula EA, van Diepen S et al. Epidemiology of shock in contemporary cardiac intensive care units. Circ Cardiovasc Qual Outcomes. 2019;12(3):e005618. https://doi.org/10.1161/CIRCOUTCOMES.119.005618

Clarke S, Ray S. Cardiology GIRFT programme national specialty report. 2021. https://gettingitrightfirsttime.co.uk/wp-content/uploads/2021/09/Cardiology-Jul21k-NEW.pdf (accessed 20 May 2023)

Hochman JS, Sleeper LA, Webb JG et al. Early revascularization in acute myocardial infarction complicated by cardiogenic shock. N Engl J Med. 1999;341(9):625–634. https://doi.org/10.1056/NEJM199908263410901

Jentzer JC, Ahmed AM, Vallabhajosyula S et al. Shock in the cardiac intensive care unit: Changes in epidemiology and prognosis over time. Am Heart J. 2021;232:94-104. https://doi.org/10.1016/j.ahj.2020.10.054

Marbach JA, Di Santo P, Kapur NK et al. Lactate clearance as a surrogate for mortality in cardiogenic shock: insights from the DOREMI trial. J Am Heart Assoc. 2022;11(6):e023322. https://doi.org/10.1161/JAHA.121.023322

McDonagh TA, Metra M, Adamo M et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J. 2021;42(36):3599–3726. https://doi.org/10.1093/eurheartj/ehab368

Naidu SS, Baran DA, Jentzer JC et al. SCAI SHOCK stage classification expert consensus update: a review and incorporation of validation studies. J Am Coll Cardiol. 2022;79(9):933–946. https://doi.org/10.1016/j.jacc.2022.01.018

Papolos AI, Kenigsberg BB, Berg DD et al. Management and outcomes of cardiogenic shock in cardiac ICUs with versus without shock teams. J Am Coll Cardiol. 2021;78(13):1309–1317. https://doi.org/10.1016/j.jacc.2021.07.044

Rathod KS, Koganti S, Iqbal MB et al. Contemporary trends in cardiogenic shock: incidence, intra-aortic balloon pump utilisation and outcomes from the London Heart Attack Group. Eur Heart J Acute Cardiovasc Care. 2018;7(1):16–27. https://doi.org/10.1177/2048872617741735

Royal College of Physicians. National early warning score (NEWS) 2: standardising the assessment of acute-illness severity in the NHS. 2017. https://www.rcplondon.ac.uk/projects/outputs/national-early-warning-score-news-2 (accessed 20 May 2023)

Samsky M, Krucoff M, Althouse AD et al. Clinical and regulatory landscape for cardiogenic shock: a report from the Cardiac Safety Research Consortium ThinkTank on cardiogenic shock. Am Heart J. 2020;219:1–8. https://doi.org/10.1016/j.ahj.2019.10.006

Shaefi S, O'Gara B, Kociol RD et al. Effect of cardiogenic shock hospital volume on mortality in patients with cardiogenic shock. J Am Heart Assoc. 2015;4(1):e001462. https://doi.org/10.1161/JAHA.114.001462

Taylor JA, Crowe S, Espuny Pujol F et al. The road to hell is paved with good intentions: the experience of applying for national data for linkage and suggestions for improvement. BMJ Open. 2021;11(8):e047575. https://doi.org/10.1136/bmjopen-2020-047575

Tehrani B, Truesdell A, Singh R et al. Implementation of a cardiogenic shock team and clinical outcomes (INOVA-SHOCK Registry): observational and retrospective study. JMIR Res Protoc. 2018;7(6):e160. https://doi.org/10.2196/resprot.9761

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(25):2419–2432. https://doi.org/10.1056/NEJMoa1710261

Thiele H, Ohman EM, de Waha-Thiele S et al. Management of cardiogenic shock complicating myocardial infarction: an update 2019. Eur Heart J. 2019;40(32):2671–2683. https://doi.org/10.1093/eurheartj/ehz363

UK Cardiogenic Shock Working Group. Shock to survival: a framework to improve the care and outcomes of people with cardiogenic shock in the UK. 2022. https://ics.ac.uk/resource/shock-to-survival-report.html (accessed 20 May 2023)

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(16):e232–e268. https://doi.org/10.1161/CIR.0000000000000525

Wood A, Denholm R, Hollings S et al. Linked electronic health records for research on a nationwide cohort of more than 54 million people in England: data resource. BMJ. 2021;373:n826. https://doi.org/10.1136/bmj.n826