Circulation Reports
Circ Rep 2025; 7: 6–14
doi:10.1253/circrep.CR-24-0141

REVIEW

Clinical Review of Cardiogenic Shock After Acute Myocardial Infarction

— Revascularization, Mechanical Circulatory Support, and Beyond —

Yuichi Saito, MD; Kazuya Tateishi, MD; Yoshio Kobayashi, MD

Owing to recent advances in early reperfusion and pharmacological therapies, the prognosis of patients with acute myocardial infarction (AMI) has considerably improved over the past decades. However, the mortality rate remains high at ~40–50% after AMI when complicated by cardiogenic shock. Although immediate coronary revascularization of the infarct-related artery has been the only evidence-based treatment, temporary mechanical circulatory support with a microaxial flow pump (Impella) has become another therapeutic option supported by randomized trial data in highly selected patients. Here we summarize the latest evidence concerning clinical challenges in patients with AMI and cardiogenic shock.

Key Words: Acute myocardial infarction; Cardiogenic shock; Mechanical circulatory support

The prognosis of acute myocardial infarction (AMI) has considerably improved over the past decades, owing to recent advances in pharmacological treatment, standardized care, and early reperfusion strategies with percutaneous coronary intervention (PCI).[1–3] However, even in the current the clinical outcomes of patients with AMI are poor when complicated by cardiogenic shock (CS). To date, short-term mortality rates (during hospitalization or at 30 days) after AMI in patients without CS have been decreasing to <5%, but remain high, ranging from 40% to 50%, in observational and randomized control trial (RCT) data.[4–12] Although immediate coronary revascularization of the infarct-related artery in patients with ST-segment elevation myocardial infarction (STEMI) has been the only evidence-based treatment strategy in the AMI-CS scenario,[6] the recent DanGer Shock trial demonstrated the potential survival benefit of a mechanical circulatory support (MCS) device in selected patients in this setting.[12] In this review, we summarize the clinical evidence concerning AMI-CS, particularly focusing on coronary revascularization, MCS devices, and patient care.

Pathophysiology, Epidemiology, and Severity

CS is a hemodynamically complex syndrome characterized by peripheral hypoperfusion and organ dysfunction due to primary cardiac impairment.[13] In general, CS is defined as systolic blood pressure (BP) <90 mmHg (for 30 min) or requiring vasoactive agents or MCS to maintain BP.[14] Although often not objective, signs of hypotension and perfusion (e.g., altered mental status and cold, clammy skin and extremities) are also important in the diagnosis of CS. Objective measures may include oliguria with urine output <30 mL/h and levels of atrial lactate >2.0–3.0 mmol/L.[14,15] There is considerable variability in CS acuity, underlying etiology, volume status, and systemic vascular resistance, for which the term "mixed CS" was recently defined.[16] Mixed CS can be categorized as CS with ≥1 additional shock etiology of such variables, most commonly with low systemic vascular resistance (e.g., inflammatory response-like syndrome).[16] Given the hemodynamic complexities and poor prognosis of patients with (mixed) CS, individualized considerations and treatment strategies are warranted (**Figure**).

Among patients with CS, AMI is the most common etiology, and CS occurs in 5–10% of cases in the setting of AMI.[17] Impaired cardiac output leads to systemic hypoperfusion and maladaptive cycles of ischemia, inflammation, vasoconstriction, and volume overload in patients with AMI-CS, resulting in multiorgan failure and death.[15] In contrast to AMI without CS, short-term mortality rates in patients with AMI-CS remains high even in the current era. Some observational studies have shown better survival rates in recent years,[4] but other observational and RCT data indicate unchanged mortality rates over past decades

Received November 7, 2024; accepted November 7, 2024; J-STAGE Advance Publication released online November 29, 2024
Department of Cardiovascular Medicine, Chiba University Graduate School of Medicine, Chiba, Japan
Y.K. is a member of *Circulation Reports*' Editorial Team.
Mailing address: Yuichi Saito, MD, Department of Cardiovascular Medicine, Chiba University Graduate School of Medicine, 1-8-1 Inohana, Chuo-ku, Chiba, Chiba 260-8677, Japan. email: saitoyuichi1984@gmail.com

ISSN-2434-0790

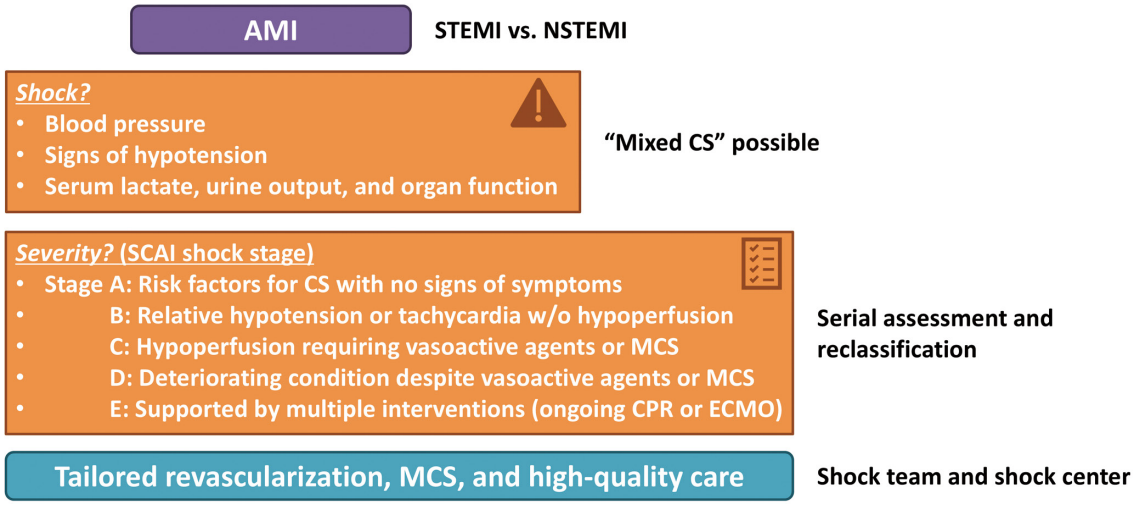

Figure. Diagnosis, severity assessment, and care of AMI-CS. The prognosis of patients with AMI complicated by CS is significantly poor. Patients with STEMI are likely to benefit from coronary revascularization and MCS, but clinical evidence for those with NSTEMI is lacking. The shock status and etiologies, including mixed CS, should be evaluated without delay. The severity of CS should be assessed with the SCAI shock stage in a serial and timely manner. To improve the outcomes of patients with AMI-CS, a tailored revascularization strategy, appropriate MCS use, and high-quality care may be needed. AMI, acute myocardial infarction; CPR, cardiopulmonary resuscitation; CS, cardiogenic shock; ECMO, extracorporeal membrane oxygenation; MCS, mechanical circulatory support; NSTEMI, non-ST-segment elevation myocardial infarction; SCAI, Society for Cardiovascular Angiography and Interventions; STEMI, ST-segment elevation myocardial infarction.

from 40% to 50% after AMI-CS.[6–12,18] In addition, AMI-CS may have worse clinical outcomes than CS related to heart failure.[19] A population-based cohort study in Canada showed that even among survivors to discharge, >40% of patients required increased support in care from their baseline, and nearly 50% were readmitted and approximately 15% died within 1 year after AMI-CS.[20] These findings highlight the need to improve short- and long-term morbidity and mortality with better medical treatment and care of patients with AMI-CS.

In order to universally define the clinical severity, and enhance care and research trials, of CS, the Society for Cardiovascular Angiography and Interventions (SCAI) shock stage was developed in 2019.[21] The diagnostic ability of the SCAI shock classification has been validated by multiple groups across a broad spectrum of CS.[21] Subsequently in 2023, the Shock Academic Research Consortium (SHARC) further proposed standardized definitions for CS research and MCS devices.[22] Although the original SCAI shock classification system lacked uniform criteria for each stage, a novel approach using clinical variables (BP, clinical presentation, and treatment intensity) and biomarkers (lactate, alanine transaminase, and pH) was proposed to define CS stages.[23] Importantly, because the severity of CS (e.g., SCAI shock stage) changes in most patients within the first 24–72 h, timely reassessment and reclassification, including response to therapy, should be considered to convey better treatment strategies and decision-making (**Figure**).[24,25]

Coronary Revascularization

Although several therapeutic strategies, such as inotropes, glycoprotein IIb/IIIa inhibitors, nitric oxide synthase inhibition, and hypothermia, have been tested in RCT settings with small sample sizes, few have shown a clinically significant benefit in patients with AMI complicated by CS.[14] Nonetheless, the pivotal SHOCK trial demonstrated that emergency coronary revascularization by PCI or coronary artery bypass grafting reduced all-cause deaths after STEMI with CS.[6] This landmark RCT included 302 patients with STEMI complicated by CS from 1993 to 1998 and randomized them into emergency revascularization (as soon as possible and within 6 h) or medical therapy (**Table 1**). Intra-aortic balloon pumping (IABP) and thrombolytic therapy were recommended and delayed revascularization (≥54 h after randomization) was allowed in the medical therapy group.[6] In fact, revascularization procedures were performed in 86.8% and 25.3% of the revascularization and medical therapy groups, respectively. The primary endpoint of the SHOCK trial, the superiority in 30-day mortality in the revascularization group, was not met, but the survival benefit of revascularization was shown at 6 months and thereafter up to 6 years.[6,26] In the current guidelines, immediate coronary angiography and PCI of the infarct-related artery are recommended in patients with CS complicating acute coronary syndrome (ACS), although the effectiveness of revascularization is uncertain ST-segment elevation is not shown on ECG.[27] Because RCTs in the field of AMI-CS are likely to enroll lower-risk patients, leading to lower mortality rates on more aggressive treatment as compared with observational studies,[28] whether the evidence from RCTs can be extrapolated to real-world clinical practice is always debatable. However, the survival benefit of PCI was confirmed in observational studies of STEMI and CS even in the elderly.[29] Additionally, in recent decades, skills and knowledge in PCI have improved considerably.[30–79] Another important RCT in

Table 1. Key Randomized Control Trials of Coronary Revascularization in AMI-CS

	SHOCK[6]	CULPRIT-SHOCK[7]
Publication year	1999	2017
Sample size	302	686
No. of study sites	30	83
Region	USA, Canada, and others	Europe (11 countries)
Intervention	Emergency revascularization	Immediate MV-PCI
Control	Medical therapy	Culprit-only PCI
Study population	STEMI	AMI
Key inclusion criteria	End-organ malperfusion[b]	MV-CAD
SBP (mmHg)	<90	<90
Lactate level (mmol/L)	NA	>2.0
Key exclusion criteria	NA	CPR >30 min
Baseline characteristics		
Age (years)	65.8[c]	70[f]
STEMI	100%	62.5%
CA or resuscitation	28.3%	53.6%
Mechanical ventilation	78–88%	81.3%
SBP (mmHg)	86.5–89.0[c]	100[f]
Heart rate (beats/min)	100.1–103.3[c]	90–91[f]
Lactate level (mmol/L)	NA	5[g]
LAD or LMCA[a]	57.4–63.6%[d]	49.8%
LVEF (%)	29.1–32.5[c]	30–33[f]
Mortality rate	46.7% vs. 56.0%[e]	51.6% vs. 43.3%[e]
Primary results	Survival benefit of emergency revascularization was not significant at 30 days but evident at 6 months	More deaths and RRT in the MV-PCI group
Safety results	No safety concerns of revascularization	Bleeding and RRT rates were numerically higher in the MV-PCI group

[a]Culprit coronary artery; [b]Cool extremities or urine output <30 mL/h and heart rate ≥60 beats/min; [c]Mean; [d]Anterior myocardial infarction; [e]At 30 days; [f]Median; [g]Approximate value. AMI, acute myocardial infarction; CA, cardiac arrest; CAD, coronary artery disease; CPR, cardiopulmonary resuscitation; CS, cardiogenic shock; LAD, left anterior descending coronary artery; LMCA, left main coronary artery; LVEF, left ventricular ejection fraction; MV, multivessel; NA, not applicable; PCI, percutaneous coronary intervention; RRT, renal replacement therapy; SBP, systolic blood pressure; STEMI, ST-segment elevation myocardial infarction.

terms of revascularization is the CULPRIT-SHOCK trial, in which the clinical benefit of immediate multivessel PCI was tested in patients with AMI-CS (**Table 1**).[7] Immediate complete revascularization in the setting of CS may intuitively improve clinical outcomes in patients with AMI and multivessel coronary disease, but the trial demonstrated no benefit, and even harm, of the immediate multivessel PCI strategy.[7] Several important limitations of the CULPRIT-SHOCK trial (e.g., crossover phenomenon, chronic total occlusion, and staged PCI) should be acknowledged,[80] but the evidence is compelling. Therefore, although immediate PCI is a valuable and standard-of-care strategy in patients with AMI-CS, routine complete revascularization should be avoided in those with multivessel coronary disease.

MCS

To theoretically improve clinical outcomes, temporary MCS devices, including IABP, extracorporeal membrane oxygenation (ECMO), and a microaxial left ventricular assist device (Impella, Abiomed, Danvers, USA), have been utilized in clinical practice. IABP is still one of the most frequently used MCS devices globally,[81] and ECMO may be unavoidable in some patient populations (e.g., refractory cardiac arrest). However, no significant benefit of these devices has been confirmed in patients with AMI-CS in RCT settings. The key RCTs, such as the IABP-SHOCK II, IMPRESS, EURO SHOCK, and the ECLS-SHOCK trials, have failed to demonstrate survival benefit of MCS devices in patients with AMI complicated by CS (**Table 2**).[8–11] Additionally, MCS devices, particularly ECMO and Impella, are associated with increased risks of major bleeding and vascular complications (**Table 2**). Thus, the 2023 European guidelines indicated that short-term MCS may be considered in patients with ACS and severe/refractory CS (Class IIb, Level of Evidence C).[27] In this context, the DanGer Shock trial successfully showed the potential survival benefit of the Impella device in patients with STEMI and CS.[12] This pivotal trial included a total of 360 patients at 14 European centers over 10 years, suggesting that the study population in the DanGer Shock was highly selected. Notable differences in the inclusion criteria between the DanGer Shock trial and other key RCTs of MCS devices include an exclusively STEMI population, higher cutoff value of systolic BP levels, and the threshold of left ventricular ejection fraction, but the greatest difference may be comatose after out-of-hospital cardiac arrest as an exclusion criterion in the DanGer Shock trial (**Table 2**). Indeed, the rates of cardiac arrest or resuscitation and mechanical ventilation at baseline were considerably lower in the DanGer Shock trial than in other RCTs (**Table 2**). The use of the Impella CP was associated with lower mortality rates than for usual care alone at 180 days in patients with STEMI and CS

Table 2. Key Randomized Control Trials of Mechanical Circulatory Support Devices in AMI-CS

	IABP-SHOCK II[8]	IMPRESS[9]	EURO SHOCK[10]	ECLS-SHOCK[11]	DanGer Shock[12]
Publication year	2012	2017	2023	2023	2024
Sample size	600	48	35	417	355
No. of study sites	37	2	15	44	14
Region	Germany	The Netherlands and Norway	Europe (6 countries)	Germany and Slovenia	Europe (3 countries)
Intervention	IABP	Impella CP	VA-ECMO	VA-ECMO	Impella CP
Control	Standard care	IABP	Standard care	Standard care	Standard care
Study population	AMI	STEMI	AMI	AMI	STEMI
Key inclusion criteria	End-organ malperfusion[b]	Mechanical ventilation	CS after primary PCI	End-organ malperfusion[b]	LVEF <45%
SBP (mmHg)	<90	<90	<90	<90	<100
Lactate level (mmol/L)	>2.0	NA	NA	>3.0	>2.5
Key exclusion criteria	CPR >30 min	NA	Ongoing CPR pH <7	CPR >45 min	Comatose after OHCA Right HF
Baseline characteristics					
Age (years)	69–70[c]	58–59[e]	67–68[c]	62–63[c]	67–69[c]
STEMI	68.9%	100%	NA	67.2%	100%
CA or resuscitation	45.0%	91.7%	48.6%	77.7%	20.3%
Mechanical ventilation	82.0%	100%	71.4%	88.9%	17.7%
SBP (mmHg)	89–90[c]	81–84[e]	82–95[c]	95–97[c]	82–84[c]
Heart rate (beats/min)	92[c]	81–83[e]	NA	90–95[c]	94–95[c]
Lactate level (mmol/L)	3.6–4.7[c]	7.5–8.9[e]	8.1–10.2[e,g]	6.8–6.9[c]	4.5–4.6[c]
LAD or LMCA[a]	52.4%	70.8%	61.8%	57.8%	71.8%
LVEF (%)	35[c]	NA[f]	20–25[c]	30[c]	25[c]
Mortality rate	39.7% vs. 41.3%[d]	45.8% vs. 50.0%[d]	43.8% vs. 61.1%[d]	47.8% vs. 49.0%[d]	45.8% vs. 58.5%[h]
Primary results	IABP did not reduce 30-day mortality	Impella CP and IABP were similar in 30-day mortality	VA-ECMO did not reduce 30-day mortality	VA-ECMO did not reduce 30-day mortality	Impella reduced 180-day mortality
Safety results	No safety concerns of IABP	More bleeding in the Impella group	More bleeding in the VA-ECMO group	More bleeding and vascular complications in the VA-ECMO group	More bleeding and other complications in the Impella group

[a]Culprit coronary artery; [b]Altered mental status, cold, clammy skin and extremities, and oliguria with urine output <30 mL/h; [c]Median; [d]At 30 days; [e]Mean; [f]LVEF <20% in 32.5% and 20–40% in 40.0%; [g]Peak level; [h]At 180 days. HF, heart failure; IABP, intra-aortic balloon pump; OHCA, out-of-hospital cardiac arrest; VA-ECMO, venoarterial extracorporeal membrane oxygenation. Other abbreviations as in Table 1.

(45.8% vs. 58.5%, P=0.04).[12] However, the survival benefit of the Impella was not significant at 30 days, which is a conventional timeframe in previous RCTs, and the device was clearly associated with increased risks of major complications.[12] The results of the DanGer Shock trial may be a milestone in the field of CS but should be cautiously interpreted, as Thile et al. mentioned.[82] Subsequently, Thiele et al. showed a patient-level meta-analysis using data from 9 RCTs of ECMO and the Impella device in patients with AMI-CS, in which active MCS device use did not result in a better survival rate at 180 days.[83] However, when focusing only on patients with STEMI and CS without risk of hypoxic brain injury, a reduction in mortality rate by use of the MCS devices was found. Thus, they concluded that MCS devices (ECMO and Impella) should be restricted to such patients only.[83] Given that several well-designed observational studies have consistently demonstrated no benefit (or even harm) of the Impella device in real-world clinical settings,[84,85] Impella use may not be recommended outside the DanGer Shock trial population. A recent registry study showed that among patients admitted to a contemporary cardiac intensive care unit, ~30% with STEMI-CS and ~5% of those with any CS presentation would meet the major eligibility criteria for the DanGer Shock trial.[86] To facilitate patient selection for MCS devices, dedicated risk scores for IABP, ECMO, and the Impella have been developed (**Table 3**).[87–89] The indication of MCS device, particularly for the Impella, may not be appropriate in patients with considerably high scores on such risk-predicting models or in those with impaired consciousness after cardiac arrest.[90] In addition, data are scarce on MCS using Impella plus ECMO.[91] Taken together, MCS devices are potentially useful in patients with AMI complicated by CS, among which the Impella device may be promising in improving clinical outcomes in highly and appropriately selected patient populations.

Medical Care in CS

In patients with ACS, particularly when complicated by CS, critical care involves management and treatment before hospitalization. For instance, prehospital 12-lead ECG performed in collaboration with emergency medical services may be associated with better ACS care.[92–99] In the hospitalization setting, team-based management in experienced centers has been shown to improve outcomes in high-mortality conditions such as trauma, sepsis, stroke, and cardiac arrest.[100] In patients with AMI complicated by

Table 3. Dedicated Risk Scores for MCS Devices

	IABP-SHOCK II risk score[87]	SAVE-score[88]	J-PVAD risk score[89]
Publication year	2017	2015	2024
MCS device	IABP	VA-ECMO	Impella
Data source	IABP-SHOCK II trial	ELSO registry	J-PVAD
Derivation cohort	AMI-CS (n=480)	CS (n=3,846)	CS (n=1,701)
No. of items	6	12	12
Components	Age; Previous stroke; BG; Creatinine; Lactate; TIMI flow grade	Etiology; Age; BW; Organ failure; CKD; Intubation duration; Inspiratory pressure; CA; DBP; PP; HCO_3; Constant value	Age; Sex; BMI; Myocarditis; IHCA; VA-ECMO; MAP; Lactate; LDH; T-Bil; Creatinine; Albumin
Outcome	30-day mortality	In-hospital mortality	In-hospital mortality
C-statistic	0.73–0.79[a]	0.68[b]	0.76[b]

[a]Internal and external validation. [b]Internal validation. BG, blood glucose; BMI, body mass index; BW, body weight; CKD, chronic kidney disease; DBP, diastolic blood pressure; ELSO, Extracorporeal Life Support Organization; IABP, intra-aortic balloon pump; IHCA, in-hospital cardiac arrest; J-PVAD, Japanese registry for Percutaneous Ventricular Assist Device; LDH, lactate dehydrogenase; MAP, mean atrial pressure; MCS, mechanical circulatory support; PP, pulse pressure; SAVE, survival after veno-arterial-ECMO; T-Bil, total bilirubin; TIMI, Thrombolysis in Myocardial Infarction. Other abbreviations as in Tables 1,2.

CS, a tailored revascularization strategy and appropriate MCS are often needed. Because these therapeutic strategies require resource-intensive skills and expertise, high-quality care may play a significant role in this patient population (**Figure**). The concept of a "shock team", consisting of specialists in critical care cardiology and MCS devices, advanced heart failure and transplant cardiology, interventional cardiology, cardiac surgery, and others, has been introduced, and the clinical effectiveness of this approach has been reported.[101,102] An observational study in North America indicated that in centers with a shock team, invasive hemodynamic monitoring and use of advanced MCS devices (e.g., ECMO and Impella) were more frequent and short-term mortality rates were lower in patients with CS, as compared with institutions without shock teams.[102] The National Cardiogenic Shock Initiative in the USA was a single-arm, prospective observation showing that treatment strategies based on a dedicated protocol for AMI-CS, including early (upfront) MCS device use, immediate PCI, invasive hemodynamic monitoring, weaning or escalation of support, and high-quality care in the intensive care unit, resulted in a relatively low mortality rate during hospitalization (i.e., 29%).[103] Similarly, the concept of "shock center" is another approach to improving the quality of care in AMI-CS. An administrative database study demonstrated an association between lower CS case volume and higher in-hospital mortality rates in shock patients.[104] In addition, volume-outcome relationships have been reported in primary PCI and with the use of MCS devices.[105–108] Therefore, appropriate institutional distribution and a regionalized shock network (i.e., "hub and spoke" model) need to be established, including transfer to shock centers at the prehospital level of emergency medical services, for the improved prognosis of patients with AMI and CS (**Figure**). The potential of other care strategies in AMI-CS (e.g., BP control) will be tested in future clinical studies.[109]

Conclusions

Immediate PCI for coronary recanalization and MCS with the Impella device may improve outcomes of patients with AMI complicated by CS, as supported by RCT data. However, the clinical evidence is largely restricted to selected patient populations. For instance, such evidence is lacking in patients with non-STEMI. Beyond revascularization and MCS, high-quality care at the institutional and regional levels with a multidisciplinary approach is relevant. Further research and action are needed to ameliorate the clinical outcomes of this vulnerable patient population.

Disclosure

Y.K. received lecture fees from Abbott Medical Japan and Daiichi Sankyo and research grants from Abbott Medical Japan, Win International, Otsuka Pharmaceutical, Boehringer Ingelheim, Nipro, and Japan Lifeline. Y.K. is a Senior Advisory Editor for *Circulation Reports*.

Source of Funding

None.

IRB Information / Data Availability

Not applicable.

References

1. Ozaki Y, Hara H, Onuma Y, Katagiri Y, Amano T, Kobayashi Y, et al. CVIT expert consensus document on primary percutaneous coronary intervention (PCI) for acute myocardial infarction (AMI) update 2022. *Cardiovasc Interv Ther* 2022; **37:** 1–34, doi:10.1007/s12928-021-00829-9.
2. Simonsson M, Wallentin L, Alfredsson J, Erlinge D, Hellstrom Angerud K, Hofmann R, et al. Temporal trends in bleeding events in acute myocardial infarction: Insights from the SWEDEHEART registry. *Eur Heart J* 2020; **41:** 833–843, doi:10.1093/eurheartj/ehz593.
3. Saito Y, Oyama K, Tsujita K, Yasuda S, Kobayashi Y. Treatment strategies of acute myocardial infarction: Updates on revascularization, pharmacological therapy, and beyond. *J Cardiol* 2023; **81:** 168–178, doi:10.1016/j.jjcc.2022.07.003.
4. Hunziker L, Radovanovic D, Jeger R, Pedrazzini G, Cuculi F, Urban P, et al. Twenty-Year trends in the incidence and outcome of cardiogenic shock in AMIS Plus Registry. *Circ Cardiovasc Interv* 2019; **12:** e007293, doi:10.1161/CIRCINTERVENTIONS.118.007293.
5. Saito Y, Inohara T, Kohsaka S, Muramatsu T, Ishii H, Yamaji K, et al. Door-to-balloon time and mortality in STEMI With cardiogenic shock: A nationwide registry. *JACC Asia* 2024; **4:** 421–422, doi:10.1016/j.jacasi.2024.03.002.
6. Hochman JS, Sleeper LA, Webb JG, Sanborn TA, White HD, Talley JD, et al. Early revascularization in acute myocardial infarction complicated by cardiogenic shock. SHOCK Investigators. Should we emergently revascularize occluded coronaries for cardiogenic shock. *N Engl J Med* 1999; **341:** 625–634, doi:10.1056/nejm199908263410901.

7. Thiele H, Akin I, Sandri M, Fuernau G, de Waha S, Meyer-Saraei R, et al. PCI strategies in patients with acute myocardial infarction and cardiogenic shock. *N Engl J Med* 2017; **377:** 2419–2432, doi:10.1056/NEJMoa1710261.
8. Thiele H, Zeymer U, Neumann FJ, Ferenc M, Olbrich HG, Hausleiter J, et al. Intraaortic balloon support for myocardial infarction with cardiogenic shock. *N Engl J Med* 2012; **367:** 1287–1296, doi:10.1056/NEJMoa1208410.
9. Ouweneel DM, Eriksen E, Sjauw KD, van Dongen IM, Hirsch A, Packer EJ, 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, doi:10.1016/j.jacc.2016.10.022.
10. Banning AS, Sabate M, Orban M, Gracey J, Lopez-Sobrino T, Massberg S, et al. Venoarterial extracorporeal membrane oxygenation or standard care in patients with cardiogenic shock complicating acute myocardial infarction: The multicentre, randomised EURO SHOCK trial. *EuroIntervention* 2023; **19:** 482–492, doi:10.4244/EIJ-D-23-00204.
11. Thiele H, Zeymer U, Akin I, Behnes M, Rassaf T, Mahabadi AA, et al. Extracorporeal life support in infarct-related cardiogenic shock. *N Engl J Med* 2023; **389:** 1286–1297, doi:10.1056/NEJMoa2307227.
12. Moller JE, Engstrom T, Jensen LO, Eiskjaer H, Mangner N, Polzin A, et al. Microaxial flow pump or standard care in infarct-related cardiogenic shock. *N Engl J Med* 2024; **390:** 1382–1393, doi:10.1056/NEJMoa2312572.
13. Arrigo M, Price S, Baran DA, Poss J, Aissaoui N, Bayes-Genis A, 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:** 1192–1202, doi:10.1016/S2213-2600(21)00172-7.
14. Thiele H, de Waha-Thiele S, Freund A, Zeymer U, Desch S, Fitzgerald S. Management of cardiogenic shock. *EuroIntervention* 2021; **17:** 451–465, doi:10.4244/EIJ-D-20-01296.
15. 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:** 879–891, doi:10.1016/j.jchf.2020.09.005.
16. van Diepen S, Poss J, Senaratne JM, Gage A, Morrow DA. Mixed Cardiogenic Shock: A Proposal for standardized classification, a hemodynamic definition, and framework for management. *Circulation* 2024; **150:** 1459–1468, doi:10.1161/CIRCULATIONAHA.124.069508.
17. Samsky MD, Morrow DA, Proudfoot AG, Hochman JS, Thiele H, Rao SV. Cardiogenic shock after acute myocardial infarction: A review. *JAMA* 2021; **326:** 1840–1850, doi:10.1001/jama.2021.18323.
18. Helgestad OKL, Josiassen J, Hassager C, Jensen LO, Holmvang L, Sorensen A, et al. Temporal trends in incidence and patient characteristics in cardiogenic shock following acute myocardial infarction from 2010 to 2017: A Danish cohort study. *Eur J Heart Fail* 2019; **21:** 1370–1378, doi:10.1002/ejhf.1566.
19. Sinha SS, Rosner CM, Tehrani BN, Maini A, Truesdell AG, Lee SB, et al. Cardiogenic shock from heart failure versus acute myocardial infarction: Clinical characteristics, hospital course, and 1-year outcomes. *Circ Heart Fail* 2022; **15:** e009279, doi:10.1161/CIRCHEARTFAILURE.121.009279.
20. Sterling LH, Fernando SM, Talarico R, Qureshi D, van Diepen S, Herridge MS, et al. Long-Term outcomes of cardiogenic shock complicating myocardial infarction. *J Am Coll Cardiol* 2023; **82:** 985–995, doi:10.1016/j.jacc.2023.06.026.
21. 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:** 933–946, doi:10.1016/j.jacc.2022.01.018.
22. Waksman R, Pahuja M, van Diepen S, Proudfoot AG, Morrow D, Spitzer E, et al. Standardized definitions for cardiogenic shock research and mechanical circulatory support devices: Scientific Expert Panel From the Shock Academic Research Consortium (SHARC). *Circulation* 2023; **148:** 1113–1126, doi:10.1161/CIRCULATIONAHA.123.064527.
23. Kapur NK, Kanwar M, Sinha SS, Thayer KL, Garan AR, Hernandez-Montfort J, et al. Criteria for defining stages of cardiogenic shock severity. *J Am Coll Cardiol* 2022; **80:** 185–198, doi:10.1016/j.jacc.2022.04.049.
24. Ton VK, Li S, John K, Li B, Zweck E, Kanwar MK, et al. Serial shock severity assessment within 72 hours after diagnosis: A Cardiogenic Shock Working Group Report. *J Am Coll Cardiol* 2024, doi:10.1016/j.jacc.2024.04.069.
25. Hanson ID, Rusia A, Palomo A, Tawney A, Pow T, Dixon SR, et al. Treatment of acute myocardial infarction and cardiogenic shock: Outcomes of the RECOVER III postapproval study by Society of Cardiovascular Angiography and Interventions Shock Stage. *J Am Heart Assoc* 2024; **13:** e031803, doi:10.1161/JAHA.123.031803.
26. Hochman JS, Sleeper LA, Webb JG, Dzavik V, Buller CE, Aylward P, et al. Early revascularization and long-term survival in cardiogenic shock complicating acute myocardial infarction. *JAMA* 2006; **295:** 2511–2515, doi:10.1001/jama.295.21.2511.
27. Byrne RA, Rossello X, Coughlan JJ, Barbato E, Berry C, Chieffo A, et al. 2023 ESC Guidelines for the management of acute coronary syndromes. *Eur Heart J* 2023; **44:** 3720–3826, doi:10.1093/eurheartj/ehad191.
28. Megaly M, Buda K, Alaswad K, Brilakis ES, Dupont A, Naidu S, et al. Comparative analysis of patient characteristics in cardiogenic shock studies: Differences between trials and registries. *JACC Cardiovasc Interv* 2022; **15:** 297–304, doi:10.1016/j.jcin.2021.11.036.
29. Damluji AA, Bandeen-Roche K, Berkower C, Boyd CM, Al-Damluji MS, Cohen MG, et al. Percutaneous coronary intervention in older patients with ST-segment elevation myocardial infarction and cardiogenic shock. *J Am Coll Cardiol* 2019; **73:** 1890–1900, doi:10.1016/j.jacc.2019.01.055.
30. Saito Y, Kobayashi Y. Contemporary coronary drug-eluting and coated stents: An updated mini-review (2023). *Cardiovasc Interv Ther* 2024; **39:** 15–17, doi:10.1007/s12928-023-00954-7.
31. Saito Y, Kobayashi Y, Fujii K, Sonoda S, Tsujita K, Hibi K, et al. CVIT 2023 clinical expert consensus document on intravascular ultrasound. *Cardiovasc Interv Ther* 2024; **39:** 1–14, doi:10.1007/s12928-023-00957-4.
32. Akase H, Okamura T, Nagoshi R, Fujimura T, Miyazaki Y, Takenaka H, et al. Risk assessment of side branch compromise after coronary bifurcation stenting: A substudy of the 3D-OCT Bifurcation Registry. *Circ J* 2024; **88:** 959–969, doi:10.1253/circj.CJ-22-0723.
33. Akashi N, Matoba T, Kohro T, Oba Y, Kabutoya T, Imai Y, et al. Sex differences in long-term outcomes in patients with chronic coronary syndrome after percutaneous coronary intervention: Insights from a Japanese real-world database using a storage system. *Circ J* 2023; **87:** 775–782, doi:10.1253/circj.CJ-22-0653.
34. Arai R, Okumura Y, Murata N, Fukamachi D, Honda S, Nishihira K, et al. Prevalence and impact of polyvascular disease in patients with acute myocardial infarction in the contemporary era of percutaneous coronary intervention: Insights from the Japan Acute Myocardial Infarction Registry (JAMIR). *Circ J* 2024; **88:** 911–920, doi:10.1253/circj.CJ-23-0477.
35. Asada K, Saito Y, Sato T, Matsumoto T, Yamashita D, Suzuki S, et al. Prognostic value of natriuretic peptide levels and in-hospital heart failure events in patients with acute myocardial infarction. *Circ J* 2023; **87:** 640–647, doi:10.1253/circj.CJ-22-0577.
36. Chen L, Zhang S, Luo M, He C, You Z, Zhang L, et al. Assessing the predictive value of different nutritional indexes for contrast-associated acute kidney injury in patients undergoing percutaneous coronary intervention. *Circ J* 2024; **88:** 902–910, doi:10.1253/circj.CJ-23-0479.
37. Emori H, Shiono Y, Kuriyama N, Honda Y, Ebihara S, Kadooka K, et al. Calcium fracture after intravascular lithotripsy as assessed with optical coherence tomography. *Circ J* 2023; **87:** 799–805, doi:10.1253/circj.CJ-22-0695.
38. Feng X, Xu Y, Zeng M, Qin Y, Weng Z, Sun Y, et al. Optical coherence tomography assessment of coronary lesions associated with microvascular dysfunction in ST-segment elevation myocardial infarction. *Circ J* 2023; **87:** 1625–1632, doi:10.1253/circj.CJ-23-0200.
39. Fujihara M, Tsukizawa T, Yazu Y, Tsujikawa S, Yokoi Y, Uesima D. Cost Change of elective percutaneous coronary artery intervention for chronic coronary syndrome in Japan from 2010 to 2019. *Circ J* 2023; **87:** 767–774, doi:10.1253/circj.CJ-22-0561.

40. Fukui K, Takahashi J, Hao K, Honda S, Nishihira K, Kojima S, et al. Disparity of performance measure by door-to-balloon time between a rural and urban area for management of patients with ST-Segment elevation myocardial infarction: Insights from the Nationwide Japan Acute Myocardial Infarction Registry. *Circ J* 2023; **87:** 648–656, doi:10.1253/circj.CJ-22-0454.
41. Hanada K, Kinjo T, Yokoyama H, Tsushima M, Senoo M, Ichikawa H, et al. Incidence, predictors, and outcome associated with ventricular tachycardia or fibrillation in patients undergoing primary percutaneous coronary intervention for acute myocardial infarction. *Circ J* 2024; **88:** 1254–1264, doi:10.1253/circj.CJ-23-0023.
42. Hanada K, Sasaki S, Seno M, Kimura Y, Ichikawa H, Nishizaki F, et al. Reduced left ventricular ejection fraction is a risk for sudden cardiac death in the early period after hospital discharge in patients with acute myocardial infarction. *Circ J* 2022; **86:** 1490–1498, doi:10.1253/circj.CJ-21-0999.
43. Horikoshi T, Nakamura T, Yamaguchi K, Yoshizaki T, Watanabe Y, Kuroki K, et al. Prognostic value of novel natriuretic peptide index after percutaneous coronary intervention. *Circ J* 2023; **87:** 296–305, doi:10.1253/circj.CJ-22-0531.
44. Horikoshi T, Nakamura T, Yoshizaki T, Nakamura J, Uematsu M, Kobayashi T, et al. Predictive value of $CHADS_2$, CHA_2DS_2-VASc and R_2-$CHADS_2$ scores for short- and long-term major adverse cardiac events in non-ST-segment elevation myocardial infarction. *Circ J* 2024; **88:** 1246–1253, doi:10.1253/circj.CJ-23-0733.
45. Ino Y, Takahata M, Kubo T, Khalifa AKM, Satogami K, Terada K, et al. Vascular Response after everolimus-eluting stent in acute myocardial infarction caused by calcified nodule. *Circ J* 2022; **86:** 1388–1396, doi:10.1253/circj.CJ-21-1059.
46. Ishihara T, Mizote I, Nakamura D, Okamoto N, Shiraki T, Itaya N, et al. Comparison of 1-month and 12-month vessel responses between the polymer-free biolimus A9-coated stent and the durable polymer everolimus-eluting stent. *Circ J* 2022; **86:** 1397–1408, doi:10.1253/circj.CJ-22-0098.
47. Iwahashi N, Gohbara M, Kirigaya J, Abe T, Horii M, Hanajima Y, et al. Prognostic significance of the combination of left atrial reservoir strain and global longitudinal strain immediately after onset of ST-elevation acute myocardial infarction. *Circ J* 2022; **86:** 1499–1508, doi:10.1253/circj.CJ-21-0907.
48. Jang AY, Kim M, Oh PC, Suh SY, Lee K, Kang WC, et al. Long-term clinical outcomes and its predictors between the 1- and 2-stent strategy in coronary bifurcation lesions: A baseline clinical and lesion characteristic-matched analysis. *Circ J* 2022; **86:** 1365–1375, doi:10.1253/circj.CJ-22-0163.
49. Kadota K, Nakao K, Nakagawa Y, Shite J, Yokoi H, Kozuma K, et al. Clinical outcomes after percutaneous coronary intervention in East Asian patients: 30-month results of the PENDULUM Registry. *Circ J* 2022; **86:** 1339–1349, doi:10.1253/circj.CJ-21-0991.
50. Kimura S, Isshiki A, Shimizu M, Fujii H, Suzuki M. Clinical significance of coronary healed plaques in stable angina pectoris patients undergoing percutaneous coronary intervention. *Circ J* 2023; **87:** 1643–1653, doi:10.1253/circj.CJ-23-0031.
51. Kobayashi T, Kitahara H, Kato K, Saito Y, Kobayashi Y. Impact of parathyroid hormone level on intracoronary calcification and short- and long-term outcomes in dialysis patients undergoing percutaneous coronary intervention. *Circ J* 2023; **87:** 247–255, doi:10.1253/circj.CJ-22-0202.
52. Koga S, Honda S, Maemura K, Nishihira K, Kojima S, Takegami M, et al. Effect of infarction-related artery location on clinical outcome of patients with acute myocardial infarction in the contemporary era of percutaneous coronary intervention: Subanalysis from the Prospective Japan Acute Myocardial Infarction Registry (JAMIR). *Circ J* 2022; **86:** 651–659, doi:10.1253/circj.CJ-21-0698.
53. Luo M, Zhu Z, Zhang L, Zhang S, You Z, Chen H, et al. Predictive Value of N-terminal pro B-Type natriuretic peptide for contrast-induced nephropathy non-recovery and poor outcomes among patients undergoing percutaneous coronary intervention. *Circ J* 2023; **87:** 258–265, doi:10.1253/circj.CJ-22-0399.
54. Moriwaki K, Kurita T, Hirota Y, Ito H, Ishise T, Fujimoto N, et al. Prognostic impact of prehospital simple risk index in patients with ST-elevation myocardial infarction. *Circ J* 2023; **87:** 629–639, doi:10.1253/circj.CJ-22-0795.
55. Muramatsu T, Masuda S, Kotoku N, Kozuma K, Kawashima H, Ishibashi Y, et al. Prasugrel monotherapy after percutaneous coronary intervention with biodegradable-polymer platinum-chromium everolimus eluting stent for Japanese patients with chronic coronary syndrome (ASET-JAPAN). *Circ J* 2023; **87:** 857–865, doi:10.1253/circj.CJ-23-0051.
56. Nakagawa Y, Kadota K, Nakao K, Shite J, Yokoi H, Kozuma K, et al. Early $P2Y_{12}$ inhibitor single antiplatelet therapy for high-bleeding risk patients after stenting: PENDULUM Mono 24-month analysis. *Circ J* 2022; **86:** 1352–1361, doi:10.1253/circj.CJ-21-1004.
57. Nakamura M, Isawa T, Nakamura S, Ando K, Namiki A, Shibata Y, et al. Drug-coated balloon for the treatment of small vessel coronary artery disease: A randomized non-inferiority trial. *Circ J* 2023; **87:** 287–295, doi:10.1253/circj.CJ-22-0584.
58. Nakamura M, Yaku H, Ako J, Arai H, Asai T, Chikamori T, et al. JCS/JSCVS 2018 Guideline on revascularization of stable coronary artery disease. *Circ J* 2022; **86:** 477–588, doi:10.1253/circj.CJ-20-1282.
59. Nakano S, Kohsaka S, Chikamori T, Fukushima K, Kobayashi Y, Kozuma K, et al. JCS 2022 Guideline Focused Update on diagnosis and treatment in patients with stable coronary artery disease. *Circ J* 2022; **86:** 882–915, doi:10.1253/circj.CJ-21-1041.
60. Nakatani S, Sotomi Y, Suzuki S, Kobayashi T, Hamanaka Y, Omatsu T, et al. Angioscopic comparison of early- and mid-term vascular responses following treatment of ST-elevation acute myocardial infarction with biodegradable vs. durable polymer everolimus-eluting stents: A prespecified subanalysis of the MECHANISM AMI RCT. *Circ J* 2023; **87:** 619–628, doi:10.1253/circj.CJ-22-0534.
61. Natsuaki M, Morimoto T, Iimuro S, Fujita R, Iwata H, Miyauchi K, et al. Thrombotic risk stratification and intensive statin therapy for secondary prevention of coronary artery disease: Insights from the REAL-CAD Study. *Circ J* 2022; **86:** 1416–1427, doi:10.1253/circj.CJ-22-0315.
62. Okabe K, Miura K, Shima Y, Ikuta A, Taguchi Y, Takahashi K, et al. Comparison and validation of long-term bleeding events for Academic Bleeding Risk (ARC-HBR) criteria and contemporary risk scores for percutaneous coronary intervention with a second-generation drug eluting stent. *Circ J* 2022; **86:** 1379–1387, doi:10.1253/circj.CJ-21-0901.
63. Okamoto H, Nishi T, Ishii M, Tsujita K, Koto S, Nakai M, et al. Clinical characteristics and outcomes of patients presenting with acute myocardial infarction without cardiogenic shock. *Circ J* 2022; **86:** 1527–1538, doi:10.1253/circj.CJ-22-0241.
64. Omori H, Kawase Y, Mizukami T, Tanigaki T, Hirata T, Okubo M, et al. Diagnostic accuracy of artificial intelligence-based angiography-derived fractional flow reserve using pressure wire-based fractional flow reserve as a reference. *Circ J* 2023; **87:** 783–790, doi:10.1253/circj.CJ-22-0771.
65. Roh JW, Bae S, Johnson TW, Heo SJ, Kim Y, Cho DK, et al. Impact of intravascular ultrasound-guided percutaneous coronary intervention in patients with acute myocardial infarction and chronic kidney disease. *Circ J* 2023; **87:** 1339–1346, doi:10.1253/circj.CJ-23-0189.
66. Sasaki K, Koeda Y, Yoshizawa R, Ishikawa Y, Ishida M, Itoh T, et al. Comparing in-hospital outcomes for acute myocardial infarction patients in high-volume hospitals performing primary percutaneous coronary intervention vs. regional general hospitals. *Circ J* 2023; **87:** 1347–1355, doi:10.1253/circj.CJ-23-0188.
67. Sawayama Y, Tomita Y, Kohyama S, Higo Y, Kodama K, Asada K, et al. Clopidogrel use in *CYP2C19* loss-of-function carriers with high bleeding risk after percutaneous coronary intervention. *Circ J* 2023; **87:** 755–763, doi:10.1253/circj.CJ-22-0826.
68. Shibata K, Wakabayashi K, Ishinaga T, Morimura M, Aizawa N, Suzuki T, et al. Feasibility, safety, and long-term outcomes of zero-contrast percutaneous coronary intervention in patients with chronic kidney disease. *Circ J* 2022; **86:** 787–796, doi:10.1253/circj.CJ-21-0905.
69. Suzuki N, Yokoi T, Kimura T, Ikeda Y, Takahashi S, Aoyagi T, et al. Prediction of slow-flow phenomenon after stent implantation using near-infrared spectroscopy in patients with acute and chronic coronary syndrome. *Circ J* 2024; **88:** 972–979, doi:10.1253/circj.CJ-23-0266.
70. Taguchi Y, Miura K, Shima Y, Okabe K, Ikuta A, Takahashi K, et al. Gastrointestinal and intracranial bleeding events after second-generation drug-eluting stent implantation: Their association with high bleeding risk, predictors, and clinical outcomes. *Circ J* 2022; **86:** 775–783, doi:10.1253/circj.CJ-21-0620.
71. Takeji Y, Morimoto T, Shiomi H, Kato ET, Imada K, Yoshikawa Y, et al. Sex differences in clinical outcomes after percutaneous coronary intervention. *Circ J* 2023; **87:** 277–286, doi:10.1253/circj.CJ-22-0517.

72. Takeuchi T, Kosugi S, Ueda Y, Ikeoka K, Yamane H, Takayasu K, et al. Impact of a cancer history on cardiovascular events among patients with myocardial infarction who received revascularization. *Circ J* 2024; **88:** 207–214, doi:10.1253/circj.CJ-22-0838.
73. Ueno H, Hoshino M, Usui E, Sugiyama T, Kanaji Y, Hada M, et al. Prognostic implications of fractional flow reserve and coronary flow reserve after drug-eluting stent implantation. *Circ J* 2024; **88:** 853–859, doi:10.1253/circj.CJ-23-0293.
74. Watanabe H, Morimoto T, Yamamoto K, Obayashi Y, Natsuaki M, Yamaji K, et al. Prevalence and effects of high-intensity statins for Japanese patients presenting with acute coronary syndrome: A post hoc secondary analysis of STOPDAPT-2 ACS. *Circ J* 2023; **87:** 657–668, doi:10.1253/circj.CJ-22-0650.
75. Won KB, Shin ES, Kang J, Yang HM, Park KW, Han KR, et al. Body mass index and major adverse events during chronic antiplatelet monotherapy after percutaneous coronary intervention with drug-eluting stents: Results from the HOST-EXAM Trial. *Circ J* 2023; **87:** 268–276, doi:10.1253/circj.CJ-22-0344.
76. Yamamoto K, Morimoto T, Natsuaki M, Shiomi H, Ozasa N, Sakamoto H, et al. Polypharmacy and bleeding outcomes after percutaneous coronary intervention. *Circ J* 2024; **88:** 888–899, doi:10.1253/circj.CJ-23-0558.
77. Yamamoto K, Shiomi H, Morimoto T, Miyazawa A, Watanabe H, Nakamura S, et al. Dual antiplatelet therapy duration after multivessel optimal intravascular ultrasound-guided percutaneous coronary intervention. *Circ J* 2023; **87:** 1661–1671, doi:10.1253/circj.CJ-23-0141.
78. Yamamoto K, Shiomi H, Morimoto T, Watanabe H, Miyazawa A, Yamaji K, et al. Comparison of the OPTIVUS-Complex PCI multivessel cohort with the historical CREDO-Kyoto Registry Cohort-3. *Circ J* 2023; **87:** 1689–1702, doi:10.1253/circj.CJ-22-0837.
79. Yufu K, Shimomura T, Kawano K, Sato H, Yonezu K, Saito S, et al. Usefulness of prehospital 12-lead electrocardiography system in ST-segment elevation myocardial infarction patients in Oita: Comparison between urban and rural areas, weekday daytime and weekday nighttime/holidays. *Circ J* 2024; **88:** 1293–1301, doi:10.1253/circj.CJ-23-0365.
80. Saito Y, Kobayashi Y. Complete revascularization in acute myocardial infarction: A clinical review. *Cardiovasc Interv Ther* 2023; **38:** 177–186, doi:10.1007/s12928-022-00907-6.
81. Saito Y, Tateishi K, Kanda M, Shiko Y, Kawasaki Y, Kobayashi Y, et al. Volume-outcome relationships for intra-aortic balloon pump in acute myocardial infarction. *Circ J* 2024; **88:** 1286–1292, doi:10.1253/circj.CJ-24-0286.
82. Lusebrink E, Binzenhofer L, Thiele H. The DanGer Shock trial: A new dawn but much to uncover. *Eur Heart J* 2024; **45:** 4181–4183, doi:10.1093/eurheartj/ehae516.
83. Thiele H, Moller JE, Henriques JPS, Bogerd M, Seyfarth M, Burkhoff D, et al. Temporary mechanical circulatory support in infarct-related cardiogenic shock: An individual patient data meta-analysis of randomised trials with 6-month follow-up. *Lancet* 2024; **404:** 1019–1028, doi:10.1016/S0140-6736(24)01448-X.
84. Almarzooq ZI, Song Y, Dahabreh IJ, Kochar A, Ferro EG, Secemsky EA, et al. Comparative effectiveness of percutaneous microaxial left ventricular assist device vs. intra-aortic balloon pump or no mechanical circulatory support in patients with cardiogenic shock. *JAMA Cardiol* 2023; **8:** 744–754, doi:10.1001/jamacardio.2023.1643.
85. Miller PE, Bromfield SG, Ma Q, Crawford G, Whitney J, DeVries A, et al. Clinical outcomes and cost associated with an intravascular microaxial left ventricular assist device vs. intra-aortic balloon pump in patients presenting with acute myocardial infarction complicated by cardiogenic shock. *JAMA Intern Med* 2022; **182:** 926–933, doi:10.1001/jamainternmed.2022.2735.
86. O'Brien CG, Brusca SB, Barnett CF, Berg DD, Baird-Zars VM, Park JG, et al. Using selection criteria from the DanGer Shock Trial in a contemporary cohort with cardiogenic shock. *J Am Coll Cardiol* 2024; **84:** 2490–2493, doi:10.1016/j.jacc.2024.08.056.
87. Poss J, Koster J, Fuernau G, Eitel I, de Waha S, Ouarrak T, et al. Risk stratification for patients in cardiogenic shock after acute myocardial infarction. *J Am Coll Cardiol* 2017; **69:** 1913–1920, doi:10.1016/j.jacc.2017.02.027.
88. Schmidt M, Burrell A, Roberts L, Bailey M, Sheldrake J, Rycus PT, et al. Predicting survival after ECMO for refractory cardiogenic shock: The survival after veno-arterial-ECMO (SAVE)-score. *Eur Heart J* 2015; **36:** 2246–2256, doi:10.1093/eurheartj/ehv194.
89. Kondo T, Yoshizumi T, Morimoto R, Imaizumi T, Kazama S, Hiraiwa H, et al. Predicting survival after Impella implantation in patients with cardiogenic shock: The J-PVAD risk score. *Eur J Heart Fail* 2024, doi:10.1002/ejhf.3471.
90. Hamilton DE, Kobe DS, Seth M, Sharma M, LaLonde T, Shah I, et al. Association between neurological status and outcomes in cardiac arrest patients undergoing PCI in contemporary practice: Insights from BMC2. *Circ Cardiovasc Interv* 2024; **17:** e014189, doi:10.1161/CIRCINTERVENTIONS.124.014189.
91. Ikeda Y, Ako J, Toda K, Hirayama A, Kinugawa K, Kobayashi Y, et al. Short-term outcomes of Impella support in Japanese patients with cardiogenic shock due to acute myocardial infarction: Japanese Registry for Percutaneous Ventricular Assist Device (J-PVAD). *Circ J* 2023; **87:** 588–597, doi:10.1253/circj.CJ-22-0476.
92. Kobayashi Y. Activities of the Emergency and Critical Care Committee of the Japanese Circulation Society in disseminating evidence of prehospital care for acute coronary syndrome. *Circ Rep* 2022; **4:** 458–460, doi:10.1253/circrep.CR-22-0083.
93. Nakashima T, Hashiba K, Kikuchi M, Yamaguchi J, Kojima S, Hanada H, et al. Impact of prehospital 12-lead electrocardiography and destination hospital notification on mortality in patients with chest pain: A systematic review. *Circ Rep* 2022; **4:** 187–193, doi:10.1253/circrep.CR-22-0003.
94. Hashiba K, Nakashima T, Kikuchi M, Kojima S, Hanada H, Mano T, et al. Prehospital activation of the catheterization laboratory among patients with suspected ST-elevation myocardial infarction outside of a hospital: Systematic review and meta-analysis. *Circ Rep* 2022; **4:** 393–398, doi:10.1253/circrep.CR-22-0034.
95. Tanaka A, Matsuo K, Kikuchi M, Kojima S, Hanada H, Mano T, et al. Systematic review and meta-analysis of diagnostic accuracy to identify ST-segment elevation myocardial infarction on interpretations of prehospital electrocardiograms. *Circ Rep* 2022; **4:** 289–297, doi:10.1253/circrep.CR-22-0002.
96. Yamaguchi J, Matoba T, Kikuchi M, Minami Y, Kojima S, Hanada H, et al. Effects of door-in to door-out time on mortality among ST-Segment elevation myocardial infarction patients transferred for primary percutaneous coronary intervention: Systematic review and meta-analysis. *Circ Rep* 2022; **4:** 109–115, doi:10.1253/circrep.CR-21-0160.
97. Nomura O, Hashiba K, Kikuchi M, Kojima S, Hanada H, Mano T, et al. Performance of the 0-hour/1-hour algorithm for diagnosing myocardial infarction in patients with chest pain in the emergency department: A systematic review and meta-analysis. *Circ Rep* 2022; **4:** 241–247, doi:10.1253/circrep.CR-22-0001.
98. Kojima S, Yamamoto T, Kikuchi M, Hanada H, Mano T, Nakashima T, et al. Supplemental oxygen and acute myocardial infarction: A systematic review and meta-analysis. *Circ Rep* 2022; **4:** 335–344, doi:10.1253/circrep.CR-22-0031.
99. Nakayama N, Yamamoto T, Kikuchi M, Hanada H, Mano T, Nakashima T, et al. Prehospital administration of aspirin and nitroglycerin for patients with suspected acute coronary syndrome: A systematic review. *Circ Rep* 2022; **4:** 449–457, doi:10.1253/circrep.CR-22-0060.
100. Mehta A, Vavilin I, Nguyen AH, Batchelor WB, Blumer V, Cilia L, et al. Contemporary approach to cardiogenic shock care: A state-of-the-art review. *Front Cardiovasc Med* 2024; **11:** 1354158, doi:10.3389/fcvm.2024.1354158.
101. Doll JA, Ohman EM, Patel MR, Milano CA, Rogers JG, Wohns DH, et al. A team-based approach to patients in cardiogenic shock. *Catheter Cardiovasc Interv* 2016; **88:** 424–433, doi:10.1002/ccd.26297.
102. Papolos AI, Kenigsberg BB, Berg DD, Alviar CL, Bohula E, Burke JA, et al. Management and Outcomes of cardiogenic shock in cardiac ICUs with versus without Shock Teams. *J Am Coll Cardiol* 2021; **78:** 1309–1317, doi:10.1016/j.jacc.2021.07.044.
103. Basir MB, Lemor A, Gorgis S, Patel KC, Kolski BC, Bharadwaj AS, et al. Early utilization of mechanical circulatory support in acute myocardial infarction complicated by cardiogenic shock: The National Cardiogenic Shock Initiative. *J Am Heart Assoc* 2023; **12:** e031401, doi:10.1161/JAHA.123.031401.
104. Shaefi S, O'Gara B, Kociol RD, Joynt K, Mueller A, Nizamuddin J, et al. Effect of cardiogenic shock hospital volume on mortality in patients with cardiogenic shock. *J Am Heart Assoc* 2015; **4:** e001462, doi:10.1161/JAHA.114.001462.
105. Saito Y, Tateishi K, Kanda M, Shiko Y, Kawasaki Y, Kobayashi Y, et al. Volume–Outcome relationships for percutaneous coro-

nary intervention in acute myocardial infarction. *J Am Heart Assoc* 2022; **11:** e023805, doi:10.1161/JAHA.121.023805.
106. Saito Y, Inohara T, Kohsaka S, Ando H, Ishii H, Yamaji K, et al. Volume–Outcome relations of percutaneous coronary intervention in patients presenting with acute myocardial infarction (from the J-PCI Registry). *Am J Cardiol* 2023; **192:** 182–189, doi:10.1016/j.amjcard.2023.01.027.
107. Saito Y, Tateishi K, Kanda M, Shiko Y, Kawasaki Y, Kobayashi Y, et al. Volume-outcome relationships for extracorporeal membrane oxygenation in acute myocardial infarction. *Cardiovasc Interv Ther* 2024; **39:** 156–163, doi:10.1007/s12928-023-00976-1.
108. Watanabe A, Miyamoto Y, Ueyama HA, Gotanda H, Jentzer JC, Kapur NK, et al. Impacts of hospital volume and patient-hospital distances on outcomes of older adults receiving percutaneous microaxial ventricular assist devices for cardiogenic shock. *Circ Cardiovasc Interv* 2024; **17:** e014738, doi:10.1161/circinterventions.124.014738.
109. Ameloot K, Jakkula P, Hastbacka J, Reinikainen M, Pettila V, Loisa P, et al. Optimum blood pressure in patients with shock after acute myocardial infarction and cardiac arrest. *J Am Coll Cardiol* 2020; **76:** 812–824, doi:10.1016/j.jacc.2020.06.043.