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Advanced Cardiogenic-shock Team versus standard care in cardiogenic SHOCK: a single centre service evaluation project

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ABSTRACT

Background Cardiogenic shock (CS) complicating acute myocardial infarction (AMI) carries high mortality. Early revascularisation improves survival, but the effect of structured multidisciplinary care on outcomes remains underexplored.

Methods and results ACT-SHOCK is a service evaluation at a UK tertiary cardiac centre. Between May 2023 and May 2024, 82 patients with AMI-related CS requiring emergent percutaneous coronary intervention (PCI) were identified using protocolised physiological criteria and managed by an Advanced Cardiogenic-Shock Team (ACT). The ACT comprised interventional cardiologists, intensivists, anaesthetists, critical care staff and cardiac physiologists, coordinating PCI and ongoing care. Outcomes were compared with 83 historical controls from the year preceding ACT roll-out, who received standard care without ACT activation. Primary endpoints were 30-day and 1-year all-cause mortality; secondary outcomes included predictors of 30-day mortality.

Within the ACT cohort, elevated lactate, critical care admission, invasive ventilation, out-of-hospital cardiac arrest and Society for Cardiovascular Angiography and Interventions (SCAI) Shock Stage E at first medical contact predicted 1-year mortality. Adjusted analyses showed ACT management was associated with lower 1-year mortality compared with standard care (HR 0.53, 95% CI 0.30 to 0.92; p=0.026). Although 30-day mortality was lower in the ACT group, this did not reach statistical significance (HR 0.71, 95% CI 0.39 to 1.29; p=0.26). Escalation from coronary care to critical care during the recovery phase occurred more promptly in the ACT group (9.7% vs 2.4%, p=0.09). At 24 hours, a smaller proportion of ACT patients remained in SCAI stages D/E compared with standard care (42% vs 48%; p=0.003).

Conclusions Implementation of physiological criteria to identify CS and activation of a multidisciplinary ACT in a UK tertiary centre was associated with earlier detection and improved 1-year survival in AMI-related CS. These pilot data support further study across multiple UK centres to inform national policy and standardise care pathways.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Cardiogenic shock remains a leading cause of death following acute myocardial infarction (AMI). Multidisciplinary shock teams have shown survival benefits in North America, but most rely on device-based interventions and specialised cardiac intensive care units (ICUs), limiting generalisability in various healthcare systems.

WHAT THIS STUDY ADDS

⇒ A physiologically triggered multidisciplinary shock team (Advanced Cardiogenic-Shock Team) was associated with improved 1-year survival in AMI-related cardiogenic shock. The model emphasises early recognition and coordinated care rather than device-based escalation and was effective even when delivered by generalist intensivists.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study supports wider adoption of structured, multidisciplinary shock pathways within UK centres with primary percutaneous coronary intervention (PPCI) services and general ICUs. The findings provide a scalable framework to standardise care and improve outcomes in cardiogenic shock.

INTRODUCTION

Cardiogenic shock (CS) is characterised by reduced cardiac output leading to inadequate end-organ perfusion. The Society for Cardiovascular Angiography and Interventions (SCAI) has developed a widely adopted classification system for stratifying shock severity.[1] In this framework, early stages (A and B) are not typically associated with hypoperfusion, although hypotension may be present in stage B. In contrast, stages C–E are defined by overt hypoperfusion

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necessitating active intervention. Numerous studies have shown that higher SCAI stages are consistently associated with increased mortality, despite heterogeneity in patient populations across validation cohorts.[2] CS remains the leading cause of death among patients presenting with acute myocardial infarction (AMI).[2 3] In this context, the landmark SHOCK trial showed that, although early invasive management did not significantly reduce 30-day mortality compared with initial medical therapy alone (46.7% vs 56.0%; p=0.11), it was associated with a significant reduction in 6-month mortality (50.3% vs 63.1%; p=0.027).[3] The role of left ventricular (LV) unloading has been tested in the recent DanGer Shock trial, which randomised 355 patients with ST-elevation myocardial infarction (STEMI) and CS to LV unloading plus standard care vs standard care alone. Routine use significantly reduced 6-month all-cause mortality (HR 0.74, 95% CI 0.55 to 0.99, p=0.04), despite higher rates of device-related complications.[4] These results suggest that the principle of LV unloading may offer a survival benefit in this high-risk population, though careful patient selection and risk–benefit consideration remain essential.

Despite advancements in percutaneous coronary intervention (PCI) and surgical revascularisation, CS continues to carry a high mortality rate, approaching 50%.[5] Additionally, 20%–30% of CS patients require more advanced rehabilitation after discharge, and nearly 50% are rehospitalised within a year.[6 7] Given the urgency and high morbidity associated with managing these patients, the potential role of a senior multispecialty shock team comprising interventional cardiology, anaesthesia and critical care specialists in improving outcomes warrants investigation, particularly when delivered through a pragmatic model that does not rely on routine invasive haemodynamic monitoring (including right heart catheterisation) or systematic use of mechanical circulatory support (MCS), thereby enhancing scalability and real-world applicability. This approach aims to facilitate early recognition of CS and offer expert management of haemodynamic instability that leads to hypoperfusion, worsening CS and organ failure. In line with this approach, the Royal College of Anaesthetists advocates for the establishment of dedicated CS teams within UK catheterisation laboratories.[8]

This service evaluation project, conducted at a high-volume tertiary centre in the UK, aimed to evaluate the impact of an advanced shock team on survival in patients with CS secondary to acute MI requiring urgent revascularisation.

METHODS

Project design and objectives

ACT-SHOCK is a single-centre service evaluation conducted at a tertiary cardiac centre in the UK, with an annual primary PCI volume of 500–600 and on-site cardiac surgery availability. Access to advanced MCS was available (Impella, extracorporeal membrane oxygenation (ECMO)), though overall utilisation was low, reflecting real-world practice. Between May 2023 and May 2024, consecutive patients with CS, as defined by the SCAI classification and secondary to AMI, were identified using protocolised physiological criteria and managed by the Advanced Cardiogenic-Shock Team (ACT) during emergent PCI. This cohort was compared with patients from the preceding 12-month period who underwent emergent PCI for AMI-related CS and received standard care without protocolised physiological assessment or ACT team involvement, identified via the British Cardiovascular Interventional Society (BCIS) audit database. CS severity was classified using SCAI staging at first medical contact. Inclusion was limited to patients aged ≥18 years with CS due to AMI necessitating urgent PCI. Exclusion criteria included CS from alternative aetiologies (eg, myocarditis, non-ischaemic cardiomyopathy, arrhythmias, valvular disease, postcardiotomy shock), out-of-hospital cardiac arrest without return of spontaneous circulation and end-stage heart failure. This analysis was registered as a service evaluation project with the host institution.

Aims

The primary endpoint was the comparison of 30-day and 1-year all-cause mortality between cohorts. In patients who survived beyond the first 24 hours following PCI, SCAI shock stage was recorded at baseline and again at 24 hours to assess early response to therapy and to explore the potential impact of the ACT pathway on early shock resolution.

Standard care

Patients in the standard care group were managed according to historical institutional practice, prior to the implementation of the ACT pathway. In this cohort, decisions regarding escalation of care during emergency PCI were made solely by the attending interventional cardiologist. If the patient was deemed to be at high risk or exhibiting physiological instability, the interventionalist could request the presence of an anaesthetist to provide support during the procedure. This involvement was non-protocolised and typically limited to a single anaesthetist of any training grade, without structured multispecialty input.

There were no formal activation protocol or predefined criteria guiding the involvement of anaesthesia, intensive care, additional nursing or operating department practitioner (ODP). Consequently, the capacity to initiate advanced organ support interventions, such as mechanical ventilation, vasoactive therapy or circulatory support, was limited and inconsistently applied. Following the procedure, patients were typically transferred to the coronary care unit (CCU) and did not receive protocolised monitoring of physiology or blood gases. There was no predefined escalation plan or structured approach to interpreting and acting on deranged parameters, which further contributed to variability in the recognition and management of clinical deterioration. Patients in this group served as the control cohort, allowing comparison

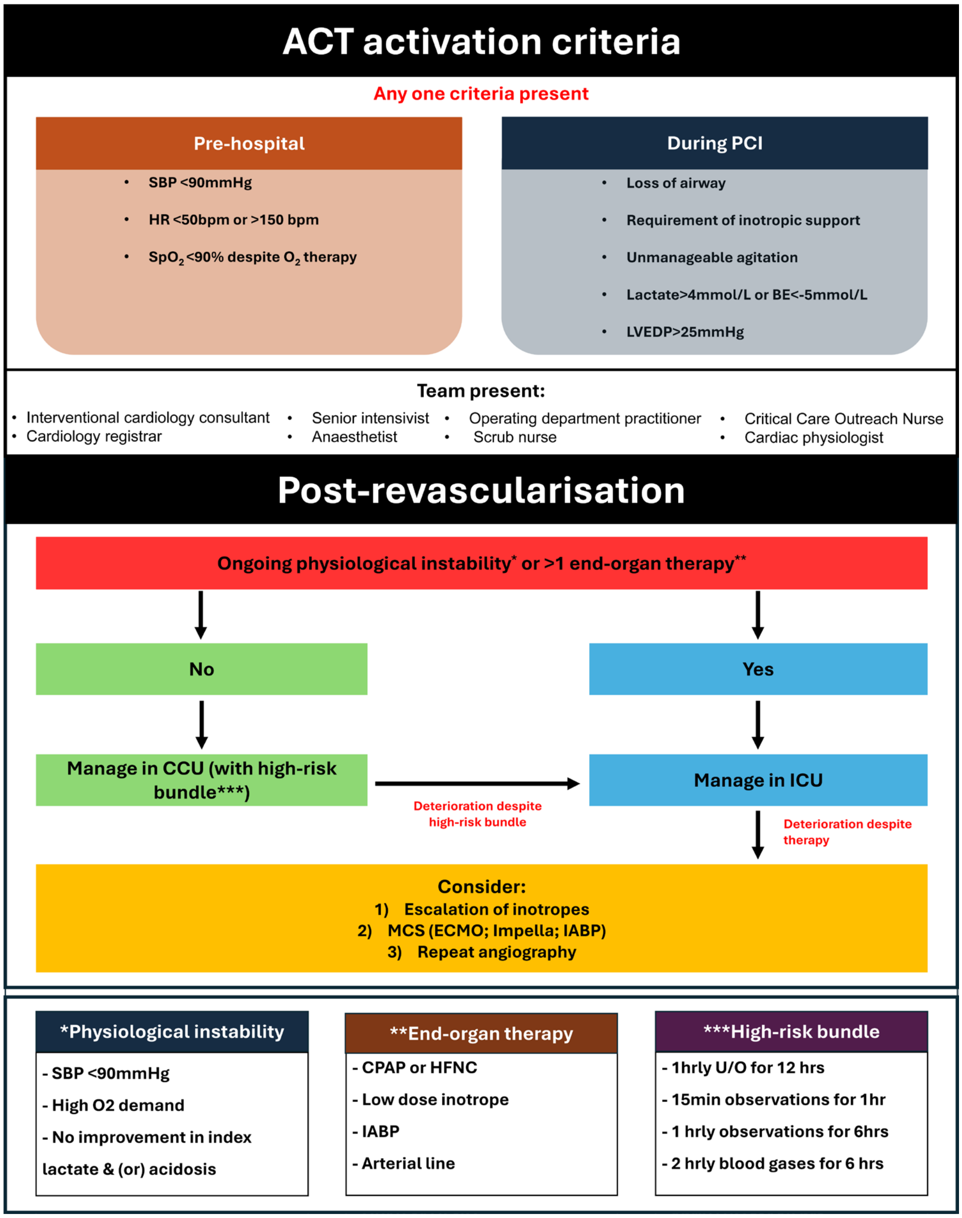

Figure 1 An Advanced Cardiogenic-Shock Team (ACT) can be activated prehospital and during percutaneous coronary intervention (PCI) as above criteria. It also outlines the patient pathway following revascularisation, including transfer to CCU or ICU. BE, base excess; BPM, beats per minute; CCU, coronary care unit; CPAP, continuous positive airway pressure; ECMO, extracorporeal membrane oxygenation; HFNC, high-flow nasal cannula; HR, heart rate; IABP, intra-aortic balloon pump; ICU, intensive care unit; LVEDP, left ventricular end diastolic pressure; MCS, mechanical circulatory support; SBP, systolic blood pressure; SpO_2, oxygen saturation; U/O, urine output.

with those managed under the ACT pathway, where a multispecialty team was mobilised based on explicit physiological criteria (figure 1).

ACT and pathway

The ACT comprises an interventional cardiology consultant, a cardiology registrar, a senior critical care physician, an anaesthetist, an ODP, a scrub nurse, a critical care outreach nurse and a cardiac physiologist. The pathway is outlined in figure 1. As part of the institution's AMI protocol, paramedics prealert the catheterisation laboratory or CCU when STEMI is suspected in the community. In the pre-ACT era, there was no formal shock team, and escalation of care was ad hoc and operator dependent, with the interventional cardiologist able only to request the presence of an anaesthetist on a case-by-case basis. During the ACT era, any team member could activate the pathway whenever predefined physiological criteria were met, ensuring that all eligible cases triggered a structured team response. The ACT was activated prior to hospital arrival if specific 'red flag' criteria were met. These include:

- Systolic blood pressure (SBP) <90 mm Hg.
- Heart rate <50 bpm or >150 bpm.

- Oxygen saturation (SpO_2) <90% despite supplemental oxygen.

ACT activation is also possible if these criteria develop at any point during PCI, or if any of the following are observed:

- Loss of airway.
- Requirement for inotropic support.
- Unmanageable agitation.
- Serum lactate >4 mmol/L or base excess <−5 mmol/L.
- LV end-diastolic pressure >25 mm Hg.

Patients with improving physiology at the end of the emergency PCI case and requiring minimal organ support (defined as 0 to 1 end-organ support modalities of high-flow nasal cannula, continuous positive airway pressure, low-dose inotropes, an arterial line in situ or an intra-aortic balloon pump (IABP)) following revascularisation may be managed on CCU with close monitoring using a high-risk CS care bundle (figure 1)— hourly urine output for 12 hours, 15 min observations for 1 hour, hourly observations for 6 hours, and 2-hourly blood gases for 6 hours. A senior cardiology review was mandated if any of the following occurred: SpO_2 <90% supplemental oxygen, SBP <90 mm Hg, lactate >4 mmol/L, base excess <−5 mmol/L, urine output <0.3 mL/kg/hour or new confusion. The CCU is staffed by cardiology consultants, resident doctors and nursing staff, without continuous intensivist cover. By contrast, patients admitted to the intensive care unit (ICU) were managed by intensivists within a general ICU environment, with cardiology input as required. This organisational structure remained consistent between the historical standard-care period and the ACT era.

In contrast, patients who have worsening or non-responding physiology, and/or require support for more than one organ system following emergency PCI should be transferred to ICU for invasive cardiovascular monitoring and support of organ systems. The advanced shock pathway did not protocolise the care once the patient reached ICU; this was left to the discretion of the treating intensivist. This included use of cardiac output monitoring, pharmacological vasoactive therapy, escalation to MCS and requirement for other organ support modalities including renal replacement therapy and ventilation. Routine invasive haemodynamic assessment using right-heart catheterisation, pulmonary artery catheter (PAC) monitoring or transpulmonary thermodilution was not performed routinely, reflecting real-world practice in UK centres.

Mechanical circulatory support

No standardised MCS selection or escalation algorithm existed in either the historical or ACT era. The choice between IABP, Impella or other devices was at the discretion of the treating clinician, guided by haemodynamic instability, access considerations, bleeding risk and device availability. Overall, MCS use was low in both cohorts, and the ACT pathway was not designed as a device-driven strategy. This approach contrasts with other shock-team models that emphasise early routine MCS.

Statistical analysis

All analyses were performed using R (V.3.6.0 or later). Continuous variables were reported as medians, and categorical variables as percentages. Comparisons between unpaired numerical variables were made using the Wilcoxon test, while categorical variables were compared using the Pearson's χ^2 test. All p values were two-tailed, with statistical significance defined as $p<0.05$. Univariate logistic regression was used to identify potential predictors of mortality. Variables deemed clinically relevant or significant on univariate analysis were incorporated into time-to-event analyses using Cox proportional hazards regression for both 30-day and 1-year all-cause mortality. Adjusted HRs with 95% CIs were reported. Post hoc analyses included: (1) sensitivity analysis of patients presenting with advanced CS (SCAI stages D/E) only and (2) a 24-hour landmark analysis excluding patients who died in extremis, with adjustment for the same covariates included in the primary model.

RESULTS

A total of 165 consecutive patients were included in the analysis, with 83 receiving standard care and 82 managed with the support of an ACT. Median age was 67±1.3 years and 71±1.3 years in the standard care and ACT group, respectively. In patients without out-of-hospital cardiac arrest, ACT was activated before hospital arrival in 19.6%, prior to PCI in 17.6%, and during PCI in 64.8% of cases. Both groups were balanced for sex, baseline demographics, ventricular function and clinical presentation (tables 1 and 2). A higher percentage of the standard care group received in GP2B3A inhibitors periprocedurally compared with the ACT group (37% vs 19%; p=0.01). Notably, a significantly greater proportion of patients in the control group were classified as SCAI shock stage E at first medical contact (72.3% vs 54.8%, p=0.03), which is accounted for in adjusted and sensitivity analyses. In terms of organ support, there was a greater number of patients in the standard care group who received invasive ventilation in comparison to the ACT group (54.7% vs 35.2%, p=0.03) (table 3). MCS was used in 11.9% in the control group versus 13.8% in the ACT group.

Following revascularisation, there were no significant differences between groups in rates of death in the catheterisation laboratory or initial admission location (CCU vs ICU). Although not statistically significant, a higher proportion of patients in the ACT group required subsequent escalation of care from CCU to ICU (9.7% vs 2.4%, p=0.09), potentially reflecting the impact of the high-risk CS care bundle in facilitating earlier identification of deterioration and timely escalation of care.

30-day and 1-year mortality were lower in the ACT group compared with the control arm (30-day—34% vs 37%; 1 year—35% vs 48.1%) (figure 2). In-hospital

Table 1 Baseline demographics

	Standard care (n=83)	ACT input (n=82)	P value
Age (years)	67±1.3	71±1.3	0.12
Sex			
Male (n (%))	59 (71)	56 (68)	0.82
Female (n (%))	24 (29)	26 (32)	0.82
Risk factors			
Diabetes (n (%))	17 (20.5)	14 (17.1)	0.7
Smoking history (n (%))	37 (44.5)	26 (31.7)	0.12
Hypertension (n (%))	41 (49.4)	31 (37.8)	0.17
Hypercholesterolaemia (n (%))	29 (34.9)	22 (26.8)	0.33
Renal dysfunction (n (%))	4 (4.8)	7 (8.3)	0.51
Family history of coronary artery disease (n (%))	22 (26.5)	11 (13.4)	0.06
Prior myocardial infarction (n (%))	18 (21.6)	17 (20.7)	1
Prior PCI (n (%))	12 (14.4)	10 (12.1)	0.84
Prior CABG (n (%))	3 (3.6)	4 (4.8)	0.98
Presentation			
STEMI (n (%))	69 (83)	72 (87.8)	0.52
NSTEMI (n (%))	14 (17)	10 (12.2)	0.52
Out of hospital cardiac arrest (n (%))	32 (38.5)	28 (34.1)	0.66
Index SCAI class			
B (n (%))	4 (4.8)	8.9 (10.9)	0.23
C (n (%))	15 (18.1)	22 (26.8)	0.24
D (n (%))	4 (4.8)	6 (7.3)	0.72
E (n (%))	60 (72.3)	45 (54.8)	0.03
Mildly reduced LV function*	6 (20)	13 (18.8)	1
Reduced LV function*	21 (70)	42 (60.9)	0.52
Impaired RV function†	10 (47.6)	21 (41.2)	0.81
Admission post revascularisation			
Death on table (n (%))	5 (6)	6 (7.3)	0.98
CCU (n (%))	30 (36.2)	25 (30.6)	0.44
Escalated to ICU from CCU (n (%))	2 (2.4)	8 (9.7)	0.09
Direct to ICU (n (%))	46 (55.4)	43 (52.4)	0.94
Total length of stay‡ (median)	9.5±1.7	11±2.3	0.31

Values are presented as median±SE or n (%). Numerical variables were compared using the Wilcoxon rank sum test and categorical variables using the χ^2 test.
*LV function available in 99 patients.
†RV function available in 72 patients.
‡Total length of stay excluding periprocedural mortality.
ACT, Advanced Cardiogenic-Shock Team; CABG, coronary artery bypass graft; CCU, coronary care unit; ICU, intensive care unit; LV, left ventricle; NSTEMI, non-STEMI; PCI, percutaneous coronary intervention; RV, right ventricle; SCAI, Society for Cardiovascular Angiography and Interventions; STEMI, ST-elevation myocardial infarction.

mortality between ACT and standard care was comparable (ACT 35.3% vs standard care 38.5%). Univariate analysis identified elevated lactate (OR 2.68, 95% CI 1.31 to 5.49, p=0.006), need for ICU admission (OR 2.36, 95% CI 1.13 to 4.96, p=0.02), invasive ventilation (OR 2.32, 95% CI 1.21 to 4.47, p=0.01) and index SCAI stage E (OR 1.96, 95% CI 1.00 to 3.81, p=0.04) as predictors of 1-year mortality. Adjusting for these covariates, management via the ACT pathway was independently associated with reduced 1 year mortality (HR 0.53, 95% CI 0.30 to 0.92; p=0.026) (online supplemental figure 1). Elevated index lactate demonstrated a strong association with mortality (HR 1.86, 95% CI 0.95 to 3.67; p=0.07), whereas SCAI stage E was not independently predictive once

Table 2 Lesion characteristics

	Standard care (n=83)	ACT input (n=82)	P value
Preoperative DAPT (n (%))	50 (60.2)	52 (63.1)	0.56
Access			
Radial artery (n (%))	66 (79.4)	57 (69.7)	0.45
Femoral artery (n (%))	17 (20.6)	25 (30.3)	0.45
Vessel			
RCA (n (%))	32 (38.4)	37 (44.7)	0.70
LCX (n (%))	22 (26.9)	24 (28.9)	0.57
LAD (n (%))	38 (46.1)	35 (42.1)	0.80
LM (n (%))	11 (12.8)	8 (9.2)	0.82
No. target lesions (n)	1.5±0.08	1.6±0.13	
Use of complex procedural adjuncts* (n (%))	14 (16.6)	13 (15.7)	1
Post-PCI TIMI<3 (n (%))	10 (11.5)	4 (5.2)	0.28
GP2B3A inhibitor use (n (%))	37 (44.8)	19 (23.6)	0.010

Numerical variables were compared using the Wilcoxon rank sum test and categorical variables using the χ^2 test.
*Use of cutting balloon, intravascular lithotripsy, rotational atherectomy, microcatheter support.
ACT, Advanced Cardiogenic-Shock Team; DAPT, dual antiplatelet therapy; LAD, left anterior descending; LCX, left circumflex; LM, left main; PCI, percutaneous coronary intervention; RCA, right coronary artery; TIMI, thrombolysis in myocardial infarction.

physiological variables were included in the model. While 30-day mortality was numerically lower in the ACT group, this difference did not reach statistical significance (HR 0.71, 95% CI 0.39 to 1.29; p=0.26). In patients presenting with advanced CS (SCAI stages D or E only; n=115), ACT management remained independently associated with improved 1-year survival (HR 0.52, 95% CI 0.28 to 0.99; p=0.045). In a 24-hour landmark analysis excluding patients who died early in extremis, ACT involvement was no longer independently associated with subsequent mortality (HR 0.80, 95% CI 0.37 to 1.72; p=0.56), although the direction of effect remained favourable.

Patients classified as SCAI stage B or C demonstrated a lower 12-month mortality compared with those in stages D or E (SCAI B – 15.3%, SCAI C – 27%, SCAI D – 50%, SCAI E – 47.6%) (online supplemental figure 2). Among patients who survived the first 24 hours, a smaller proportion of the ACT cohort remained in SCAI stages D or E compared with the standard care cohort (42% vs 48%; p=0.003).

Table 3 Haemodynamics and organ support

	Index			24 hours		
	Standard care (n=83)	ACT input (n=82)	P value	Standard care (n=78)	ACT input (n=76)	P value
SBP ≤90 mm Hg (n (%))	41 (48.8)	36 (44)	0.58	27 (34.1)	29 (38.1)	0.81
Lactate ≥2 mmol/L (n (%))	54 (65.4)	57 (69.5)	0.77	45 (58.2)	42 (55.2)	0.81
pH ≤7.2 (n (%))	49 (59)	9 (10.9)	<0.001	7 (8.8)	4 (5.2)	0.54
Need for inotropes (n (%))	58 (70.2)	52 (63.4)	0.37	41 (53.1)	42 (55.2)	0.27
IABP (n (%))	9 (10.7)	6 (7.3)	0.60	9 (11.4)	5 (6.5)	1
Impella (n (%))	1 (1.2)	5 (6.5)	0.20	0 (0)	3 (3.9)	n/a
Invasive ventilation (n (%))	45 (54.7)	29 (35.3)	0.03	39 (50.6)	36 (47.2)	0.12
GCS<15 (n (%))	46 (55.9)	33 (40.2)	<0.001	43 (55.7)	36 (47.3)	0.31
ALT>200 (n (%))	n/a	n/a	n/a	14 (17.7)	19 (25)	0.31
Highest creatinine	n/a	n/a	n/a	106	96	0.93

Numerical variables were compared using Wilcoxon rank sum test and categorical variables using the χ^2 test.
ACT, Advanced Cardiogenic-Shock Team; ALT, Alanine Aminotransferase; GCS, Glasgow Coma Score; IABP, intra-aortic balloon pump; n/a, not available; SBP, systolic blood pressure.

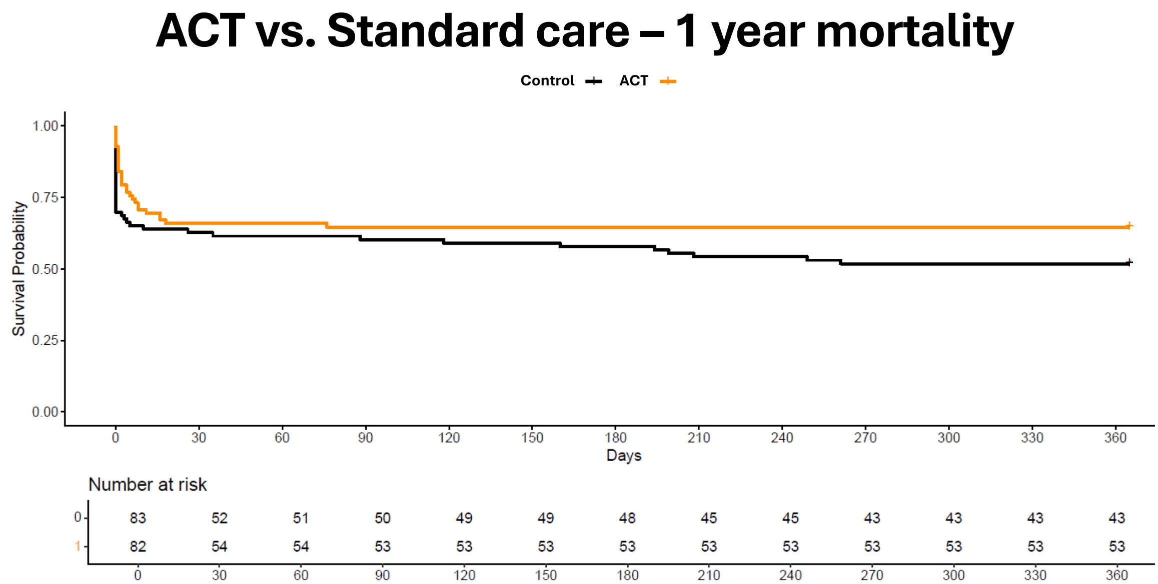

Figure 2 The Kaplan-Meier plot demonstrating lower event rates with shock team support for both 30-day and 1-year mortality compared with the standard care only. ACT, Advanced Cardiogenic-Shock Team.

DISCUSSION

ACT-SHOCK evaluated the impact of a multispecialty shock team on outcomes in patients with AMI-related cardiogenic shock. Management via the ACT pathway was associated with improved 1-year survival compared with standard care. Although 30-day mortality was numerically lower, this did not reach statistical significance, likely reflecting limited power to detect differences in a high-risk population.

Several studies have evaluated structured CS teams. Tehrani *et al* reported outcomes from 204 CS patients managed with a shock team integrating critical care, advanced heart failure, interventional cardiology and cardiac surgery, using early PAC guided haemodynamics and protocolised MCS escalation. Using this strategy, survival improved from a historical 47% to 58% in the first year and 77% in the second year of follow-up.[9] Hérion *et al*[10] reported improved 1-year survival rates (59% vs 45%) through a multispecialty shock team-based decision for MCS implantation in refractory CS. Furthermore, a multicentre observational study involving 1242 patients across sites in Canada and the USA found that hospitals with dedicated shock teams had significantly lower cardiac ICU mortality rates (23% vs 29%, p=0.025) and a reduced need for invasive mechanical ventilation (41% vs 52%, p<0.001).[11] Of interest, centres with shock teams were more likely to use PAC-guided haemodynamics and advanced MCS.

ACT-SHOCK differs from prior shock-team studies in several important respects. Care was delivered in general ICUs rather than dedicated cardiac ICUs, the pathway was physiologically triggered rather than PAC-guided, and overall advanced MCS utilisation was low (Impella 14%, ECMO 6%). Despite these differences, a substantial proportion of patients presented with severe shock (SCAI stages D or E, 62.1%) and out-of-hospital cardiac arrest (34.1%) during the ACT era, indicating that the pathway captured a meaningful high-risk population. While prior studies have emphasised early deployment of MCS and invasive haemodynamics, such strategies may not be feasible or widely accessible in many healthcare systems. In contrast, the ACT pathway adopts a holistic, multispecialty approach that prioritises systematic triage, timely recognition and coordinated care rather than device-based escalation. Importantly, although conducted in a tertiary cardiac centre, anaesthesia and intensive care input was provided by generalists without specific cardiac subspecialty training, and patients requiring ICU care were managed in a general ICU.

The observed benefit appears to relate to the early phase of care, with the ACT pathway facilitating structured recognition of shock, timely escalation and physiological stabilisation. This is supported by a lower proportion of patients presenting in SCAI stage E, appropriate escalation from CCU to ICU and a reduced likelihood of remaining in severe shock at 24 hours among ACT-managed survivors. Sensitivity analyses restricted to patients with advanced shock (SCAI stages D/E) confirmed that the association with improved 1-year survival was not driven by inclusion of less severe cases.

The absence of an independent association with 30-day mortality, together with neutral landmark analyses, suggests that the principal effect of ACT occurs early by limiting progression to irreversible shock. This temporal pattern likely reflects the natural history of AMI-related CS. Early mortality is predominantly driven by irreversible myocardial injury, severe metabolic derangement and rapid progression to multiorgan failure, which may be insufficiently modifiable at presentation.[12] Patients who survive the initial high-risk period remain vulnerable to progressive cardiac failure and recurrent decompensation, contributing to late mortality. Similar patterns have been observed in prior CS studies, including the SHOCK trial,[3] in which early revascularisation conferred a survival advantage that emerged predominantly at longer-term follow-up, and the DanGer Shock trial,[4] where LV unloading reduced 6-month mortality despite limited early separation of survival curves.

Managing CS remains a significant challenge, even within well-resourced healthcare systems. Despite advances in supportive therapies, outcomes remain poor, with high mortality and considerable morbidity, including organ failure and prolonged stays in critical care.[13] The median length of stay in patients who survived the revascularisation procedure was 11 days in the ACT group and 9.5 days in the standard care cohort. The limited success of vasoactive drugs and novel devices for CS in randomised clinical trials suggests that a single approach strategy is insufficient.[14–16] Protocolised recognition of shock using key physiological variables to activate a specialist shock team and provide more standardised, patient-centred care offers a promising alternative. As shown in online supplemental figure 2, survival differs markedly by SCAI stage, with patients in stages B and C experiencing significantly lower mortality compared with those in stages D and E. However, once patients reached stage D or E, the benefit from ACT appeared to reduce, which aligns with the notion that early identification and intervention is crucial to improving outcomes in CS (online supplemental figure 2).

Implementation and generalisability

While structured CS teams have shown promise, several factors may limit their adoption in some settings, including staffing constraints, variability in local infrastructure and institutional resistance to multispecialty collaboration. Importantly, the ACT pathway is designed to be implementable across a broad range of hospitals, including district general hospitals, rather than relying on centralisation in tertiary centres. It uses simple physiological triggers for early recognition, structured multispecialty input and timely escalation, without requiring routine invasive haemodynamic monitoring, advanced ICU infrastructure or default MCS. These core principles can be applied in any PCI-capable centre with access to a general ICU, making the approach highly generalisable. Local adaptation may be needed for staffing and escalation logistics, but the pathway's focus on early recognition and coordinated care provides a practical and scalable model. Given the single-centre, observational design involving AMI-related shock only, these findings remain hypothesis-generating and warrant validation in multicentre studies across diverse causes of shock.

Limitations

The retrospective observational design and restriction to AMI-related CS limit generalisability, and residual confounding cannot be excluded despite multivariable adjustment. The modest sample size may have limited power to detect differences in 30-day mortality, raising the possibility of a type II error. Cohort identification differed between groups, with standard care patients identified from the BCIS audit, in which CS is coded at the discretion of the reporting operator, and ACT patients identified by pathway activation. This may have introduced selection bias, including a higher proportion of SCAI stage E presentations in the standard care cohort. Although analyses were adjusted for SCAI stage at first presentation, differences in case ascertainment remain a limitation.

Routine invasive haemodynamic assessment was not performed, limiting physiological characterisation and the precision of shock staging, particularly at the more severe end of the spectrum. Landmark and sensitivity analyses reduce, but cannot fully eliminate, bias related to early deaths in extremis. Data on cause-specific mortality, rehospitalisation, optimisation of guideline-directed medical therapy and access to advanced heart failure therapies during follow-up were not available, limiting mechanistic interpretation of the observed 1-year survival difference. Finally, as early physiological recognition and multispecialty team activation were implemented as an integrated care bundle, the independent contribution of each component cannot be determined; however, this reflects real-world practice, where these elements are likely to act synergistically.

CONCLUSIONS

The ACT-SHOCK service evaluation project demonstrated successful integration of a multispecialty CS team, activated by protocolised physiological criteria, within a UK tertiary cardiac centre. The findings suggest a potential 1-year survival benefit for patients with AMI-related CS undergoing urgent revascularisation, likely mediated through earlier detection of shock, timely escalation of care and coordinated multispecialty senior input. These encouraging pilot data highlight the need for a larger, multicentre study involving other UK centres and encompassing a broader range of CS phenotypes, to inform national policy and support the standardisation of care pathways.

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