



Cardiogenic Shock Teams and the Hub-and-Spoke Model: Does the Team Change the Outcome or Only the Pathway?

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Abstract

Cardiogenic shock carries an in-hospital mortality that has fallen only modestly over two decades, and much of the field's recent optimism rests not on a new drug or device but on how care is organized: dedicated multidisciplinary shock teams, and regionalized hub-and-spoke networks that route patients to centers with that expertise. The observational signal is consistent and comes from more than one design: a single-center before-after comparison found 30-day survival rising from 47% to 76.6% after a standardized shock-team protocol; a 24-center registry found lower risk-adjusted mortality where a shock team existed (23% versus 29%, adjusted odds ratio 0.72); and a national claims analysis found lower mortality among patients transferred to an expert hub (adjusted odds ratio 0.73), despite those transferred patients being sicker on average. No randomized trial has tested a shock team or a regionalized network as its own intervention, however, and each observational design carries a bias a trial would remove: secular improvement in device technology, referral and survivor selection, and the fact that clinicians choose who gets transferred. We set the team and network literature directly against the device trials that do carry randomized evidence, and argue that the field has good reason to keep building shock teams and hub-and-spoke networks, but not yet the evidence to say which part of that reorganization is doing the work.

Keywords: Cardiogenic shock; Shock team; Regionalization; Hub-and-spoke; Mechanical circulatory support

Introduction

Cardiogenic shock complicates roughly 5-10% of acute myocardial infarctions and carries an in-hospital mortality that, despite four decades of trial activity, still sits close to 40-50% [2,3]. Incidence has been broadly stable over fifteen years of U.S. hospitalization data while in-hospital mortality has fallen only gradually, a pattern more consistent with incremental gains in supportive care than with any single breakthrough [3]. The classification of shock itself has matured: the Society for Cardiovascular Angiography and Interventions (SCAI) staging system, from Stage A ("at risk") to Stage E ("extremis"), gave

the field a common language for severity that earlier trials lacked, and has since been validated across multiple registries [1,21].

Against that backdrop, two organizational ideas have moved from single-center enthusiasm to widespread practice over the past decade. The first is the multidisciplinary shock team: interventional cardiology, heart failure and cardiac surgery, critical care and cardiac anesthesia meeting to agree a hemodynamic diagnosis and an escalation plan before, rather than during, a crisis [10,11]. The second is the hub-and-spoke network: a regional system in which community "spoke" hospitals recognize and stabilize shock, and transfer to a "hub"

center equipped with a shock team, mechanical circulatory support (MCS) and surgical backup [12]. A later figure sets out that structure schematically. Both ideas are explicitly modelled on earlier regionalization successes in trauma and ST-elevation myocardial infarction (STEMI) care [22,23], and on the pulmonary embolism response team (PERT) model in venous thromboembolism [24]. This review asks a narrower question than whether these ideas are appealing, which they plainly are: what does the evidence actually show has changed, and how confident can that attribution be?

Figure 1 frames the honest complication this review returns to throughout. Cardiogenic shock care now has genuine randomized-trial evidence for individual devices — some positive, some negative — sitting alongside a much larger, entirely observational literature on shock teams and regionalized networks. That asymmetry matters, because it is the team and network literature that increasingly drives how hospitals organize care, while carrying the weaker evidentiary standard of the two.

THE EVIDENCE BASE, BY QUESTION ASKED

Does this specific device help?	Randomized trials exist (DanGer Shock, ECLS-SHOCK, IABP-SHOCK II, CULPRIT-SHOCK)
Does a shock team change mortality?	Single-center and multicenter observational comparisons only (no randomized trial)
Does regionalization to a hub change mortality?	Registry and claims-based cohorts only (no randomized trial)

Figure 1: The evidence base for cardiogenic shock care, by the question being asked. Randomized trials exist for individual devices; no randomized trial has tested a shock team or a regionalized network as its own intervention.

Material and Methods

This is a narrative review, not a systematic review or a new meta-analysis. The literature was assembled by searching PubMed/MEDLINE for studies of shock teams, regionalized networks of care, and randomized device trials in cardiogenic shock, supplemented by the reference lists of recent consensus statements and scientific statements [1,2,25] and by each named study's own citing literature. Priority went to the largest or first report of each named cohort or trial; where a study was later updated with a larger sample or longer follow-up, the more complete report is cited.

Every survival percentage, odds ratio, hazard ratio and confidence interval reproduced here is taken directly from the cited primary report; none was recalculated by the present authors. Where a study design lacks a concurrent control group, that is stated explicitly rather than left for the reader to infer, since the distinction is the central argument of this review.

Results

What a shock team is associated with

Table 1 summarises the principal studies of shock-team and network-of-care models. The earliest widely cited report came from a single U.S. center that implemented a standardized, algorithm-driven shock team in 2017: 30-day survival rose from 47% in the twelve months before the team to 76.6% in the twelve months after, without a concurrent control group [10]. A subsequent multicenter analysis compared 24 cardiac intensive care units in a critical-care cardiology registry, 10 of which operated a shock team; among 1,242 admissions with cardiogenic shock, shock-team centers used pulmonary artery catheters more often (60% versus 49%) and used advanced mechanical circulatory support more often even though overall MCS use was lower (35% versus 43%), and cardiac intensive care unit mortality was lower where a shock team was present (23% versus 29%; adjusted odds ratio 0.72, 95% CI 0.55-0.94, $p=0.016$) [11]. Figure 2 sets this alongside the comparable estimate for hub-and-spoke transfer, discussed below; the two adjusted odds ratios are strikingly similar in magnitude, around 0.72-0.73. An earlier single-center proof-of-concept report, comparing 123 consecutive patients managed after a structured shock team was introduced against 121 preceding patients managed without one, found lower 30-day mortality after the team's introduction (hazard ratio 0.61, 95% CI 0.41-0.93) and higher in-hospital survival (61.0% versus 47.9%, $p=0.041$), with no delay in the time from shock recognition to mechanical circulatory support [13].

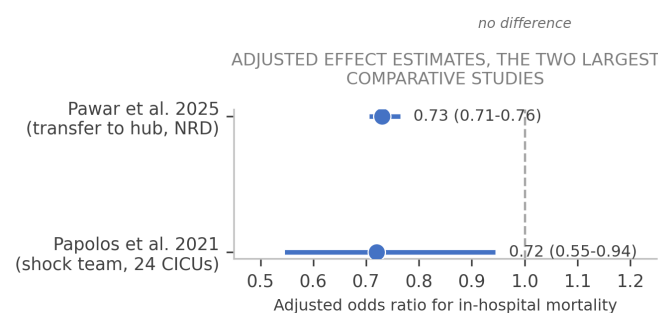


Figure 2: Adjusted odds ratios for in-hospital or intensive-care mortality from the two largest comparative studies: a shock-team-versus-no-shock-team registry and a transferred-versus-not-transferred national claims analysis [11,17].

A related but separate strand of evidence concerns standardized protocols for mechanical circulatory support timing rather than the team construct itself. The National Cardiogenic Shock Initiative (NCSI) enrolled acute myocardial infarction patients with cardiogenic shock at more than 80 U.S. sites under a protocol mandating early hemodynamic support before percutaneous coronary intervention, targeting a door-to-support time under 90 minutes; initial results across the first sites reported improved survival associated with protocol adherence [14], and the final cohort of 406 consecutive patients reported 71% survival to

hospital discharge [15]. That figure was compared against historical benchmarks from the SHOCK trial itself, which found 30-day mortality of 46.7% with early revascularization versus 56.0% with initial medical stabilization (relative risk 0.83, 95% CI 0.67-1.04, $p=0.11$) [4], and from the IABP-SHOCK II and CULPRIT-SHOCK trial populations, rather than against a contemporaneous control arm enrolled under the same protocol [15]. Figure 3 places both single-arm comparisons side by side: Tehrani's single-center shock-team result and the NCSI protocol result move in the same direction and by a similar margin, but neither has a concurrent comparator, so a temporal trend common to both eras — improving background critical care, wider availability of percutaneous MCS — cannot be excluded as a partial explanation.

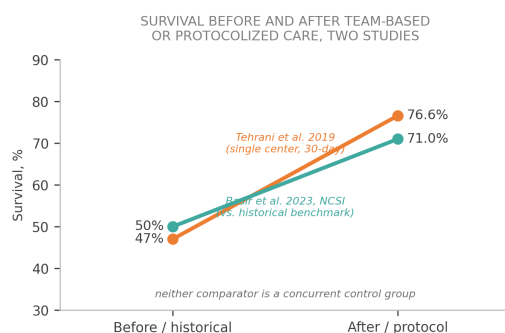


Figure 3: Survival before and after implementation of team-based or protocolized care in two influential single-arm reports. Neither comparator is a concurrent control group enrolled under the same protocol [10,15].

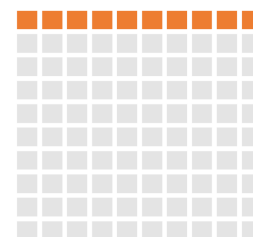
Study	Design	Setting	Comparison
Tehrani et al. 2019	Single-center, before-after	1 U.S. center	30-day survival 47% to 76.6%
Papalos et al. 2021	Multicenter registry	24 U.S. CICUs	Mortality 23% vs 29%, aOR 0.72
Tehrani et al. 2022	Regional network, before-after	1 hub + 6 spokes, northern Virginia	Network launched; no concurrent control
Basir et al. 2023, NCSI	Single-arm registry	>80 U.S. sites	71% survival vs historical benchmark
Pawar et al. 2025	Retrospective national cohort	National Readmissions Database, 314,098 pts	Mortality 39.1% vs 47.1%, aOR 0.73

Table 1: Principal studies of shock-team and regionalized-network models. Every design listed is observational; none is a randomized comparison of team-based versus ad hoc care [10-12,15,17].

The transfer signal, and why it resists simple selection bias

The most recent and largest analysis of regionalization used the National Readmissions Database to identify 314,098 U.S. hospitalizations for cardiogenic shock between 2016 and 2020, of which only 9.8% involved transfer to a hub-type center [17]. Figure 4 shows how small that transferred fraction is. In-hospital mortality was lower among transferred patients (39.1% versus 47.1%; adjusted odds ratio 0.73, 95% CI 0.71-0.76), and transferred patients also had shorter adjusted length of stay and lower costs, though 30-day readmission was higher [17]. What makes this result harder to dismiss as pure selection of healthier patients is that transferred patients carried a heavier burden of comorbidity and organ failure on average, not a lighter one [17] — the direction one would expect to bias the comparison against transfer, not in its favour. A separate single-network analysis of patients who developed shock at a spoke hospital and were subsequently transferred similarly found that younger age, shorter spoke length of stay, and transfer from a lower rather than higher acuity facility were each associated with better outcomes after arrival at the hub [18], consistent with a real benefit to earlier transfer rather than only to transfer per se.

SHARE OF U.S. CARDIOGENIC SHOCK PATIENTS TRANSFERRED TO AN EXPERT HUB, 2016-2020



9.8% transferred (n=314,098, National Readmissions Database) [11]

Figure 4: Share of U.S. cardiogenic shock hospitalizations, 2016-2020, that involved transfer to an expert hub center. Only about one in ten did [17].

Even so, an administrative database built from diagnosis and procedure codes cannot capture hemodynamic severity at the moment a transfer decision is made, and the decision to transfer is never random: it is made by a clinician who already expects it to help, which is a form of confounding by indication that adjustment for recorded comorbidity cannot fully remove. A formal cost-effectiveness analysis of the shock-team approach, modelled on a single high-volume network, found the approach likely cost-effective by conventional thresholds when the observed survival difference was assumed causal [19] — a calculation whose economic conclusion is only as strong as that causal assumption.

The pathway: what a team or network is actually claimed to change

If shock teams and regionalized networks are not the same intervention as any single device, what is the mechanism by which they are proposed to help? Figure 5 sets out the pathway most commonly described: recognition of shock at the spoke, activation of a shock team or consultation with one, hemodynamic profiling and SCAI-stage assignment, protocol-driven escalation of mechanical support where indicated, a transfer decision, and arrival at a hub for definitive care. Several of these individual steps have their own, more direct supporting evidence. Complete hemodynamic profiling with a pulmonary artery catheter, of the kind shock teams use more often, has itself been associated with lower in-hospital mortality in a multicenter registry analysis (odds ratio reported by the study authors, adjusting for shock severity and other confounders) [20], independent of whether a formal shock team existed at that center. That raises a genuine possibility the title of this review poses directly: some or all of the benefit attributed to "having a shock team" may run through discrete, measurable process changes — more hemodynamic profiling, faster support, a clearer transfer pathway — that a team happens to reliably produce, rather than through the team's multidisciplinary structure being causal in itself.

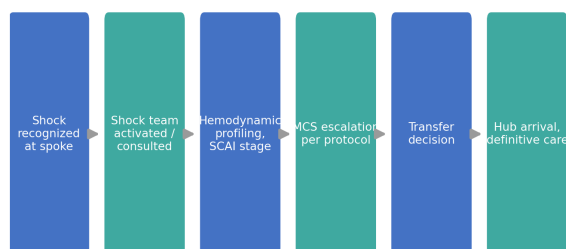


Figure 5: The care pathway a shock team or regionalized network is intended to standardize, from recognition at a spoke hospital to definitive care at a hub.

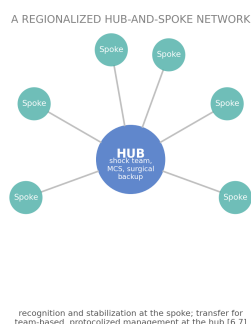


Figure 6: A regionalized hub-and-spoke network of care for cardiogenic shock. Spoke hospitals recognize and stabilize shock; the hub concentrates shock-team expertise, mechanical circulatory support and surgical backup [12].

Where the randomized evidence actually sits

Table 2 sets out the four largest randomized trials in cardiogenic shock, none of which tested a team or network model. Two were negative for their tested device: IABP-SHOCK II found no 30-day mortality difference with an intra-aortic balloon pump (39.7% versus 41.3%; relative risk 0.96, 95% CI 0.79-1.17, $p=0.69$) [5], and ECLS-SHOCK found no 30-day mortality difference with routine venoarterial extracorporeal membrane oxygenation (47.8% versus 49.0%, $p=0.81$), at the cost of more moderate-or-severe bleeding (23.4% versus 9.6%) and more peripheral vascular complications (11% versus 3.8%) [8], a result consistent with an earlier, smaller trial of immediate versus conservative VA-ECMO in a similar population, which also found no significant difference in its 30-day composite outcome of death, resuscitated cardiac arrest, or need for mechanical circulatory support (63.8% versus 71.2%; hazard ratio 0.72, 95% CI 0.46-1.12, $p=0.21$) [9]. Two were positive: CULPRIT-SHOCK found culprit-lesion-only percutaneous coronary intervention reduced 30-day death or renal-replacement therapy compared with immediate multivessel intervention (45.9% versus 55.4%; relative risk 0.83, 95% CI 0.71-0.96) [6], and DanGer Shock, the most recent, found a microaxial flow pump added to standard care reduced death from any cause at 180 days compared with standard care alone (45.8% versus 58.5%; hazard ratio 0.74, 95% CI 0.55-0.99, $p=0.04$), at the cost of more renal-replacement therapy, bleeding and a composite safety endpoint of device-related complications (24.0% versus 6.2%) [7].

Trial	Intervention tested	N	Primary result
IABP-SHOCK II	Intra-aortic balloon pump	600	No benefit (39.7% vs 41.3%, $p=0.69$)
CULPRIT-SHOCK	Culprit-only vs multivessel PCI	706	Favoured culprit-only (45.9% vs 55.4%)
ECLS-SHOCK	Routine VA-ECMO	417	No benefit (47.8% vs 49.0%, $p=0.81$)
DanGer Shock	Microaxial flow pump (Impella CP)	355	Favoured device (45.8% vs 58.5%, HR 0.74)

Table 2: The four largest randomized trials in cardiogenic shock. Each tests a single device against standard care; none tests a shock team or a regionalized network of care as the randomized intervention [5-8].

Discussion

The observational case for shock teams and regionalized hub-and-spoke networks is more consistent than most single-center quality-improvement literature: a similar-sized adjusted effect appears in a before-after single-center study, a 24-center registry comparison, and a national transfer-outcomes analysis using an entirely different data source and population [10,11,17]. Findings that reproduce across independent designs and independent groups deserve more weight than a single report of either kind. That consistency is exactly why the field has moved, sensibly, toward building shock teams and formal referral networks rather than waiting for a trial that may never be practical to run: cluster-randomizing hospitals to "have a shock team" or not, with real patients and real families making real-time decisions, raises the same ethical and logistical difficulties that have kept trauma-center and STEMI regionalization from ever being tested by a patient-level randomized trial either [22,23]. Those systems of care are now considered a settled part of good practice on the strength of exactly the kind of observational, before-after and cross-sectional evidence at issue here.

But the title of this review asks a question the observational literature cannot yet answer on its own: does the team change the outcome, or only the pathway? Three specific confounds run through every study in Table 1. First, secular trend: the years separating "before" from "after" in Tehrani's single-center report, and separating the historical benchmarks from NCSI's protocol cohort, also saw wider availability of percutaneous mechanical circulatory support and incremental gains in general critical care, either of which could explain part of an improvement attributed entirely to the team or the protocol [10,15]. Second, referral and survivor selection: a patient transferred from a spoke to a hub must survive the transfer itself to be counted, and the clinicians who decide to transfer are not blinded to how sick a patient looks, which is a textbook confounding-by-indication problem that adjustment for recorded comorbidity cannot fully resolve, however reassuring it is that transferred patients were sicker rather than healthier on average in the largest such analysis [17]. Third, bundling: a "shock team" is not one variable but a bundle of simultaneous changes — more pulmonary artery catheter use, faster mechanical support escalation, protocolized transfer criteria — and the one process step with its own more direct supporting evidence, hemodynamic profiling, may be doing a disproportionate share of the work [11,20]. None of these three confounds is a reason to think the observed associations are false; each is a reason the causal attribution to "the team" specifically, as opposed to the pathway a team reliably produces, remains open.

The four device trials in Table 2 show what a cleaner answer looks like when it is available, and how mixed even

that cleaner evidence is: a balloon pump and routine early ECMO both failed to move 30-day mortality despite decades of physiological rationale and enthusiasm comparable to today's enthusiasm for shock teams, while a simpler revascularization strategy and a newer percutaneous pump both succeeded [5-8]. That record argues against assuming any organizational or technological innovation in this field will pan out simply because the physiological logic is appealing and the observational signal is positive; IABP-SHOCK II and ECLS-SHOCK were both preceded by exactly that kind of appealing logic and positive early experience. The explicit calls from within the field for a shared shock-team registry, modelled on the pulmonary embolism response team consortium that faced an identical evidence critique a decade earlier [24], and for prospective, ideally randomized evaluation of team-based care itself [16], are the appropriate response to that record: not abandoning a plausible and probably beneficial reorganization of care, but building the infrastructure to find out which part of it is doing the work before that reorganization hardens into unquestioned practice.

Study limitations

This is a narrative synthesis, not a systematic review, and although the search was broad it followed no pre-registered protocol. The studies compared in Table 1 differ substantially in population, era, definition of a "shock team", and outcome window (30-day, in-hospital or index-admission mortality are not interchangeable), so the similarity of their adjusted effect sizes in Figure 2 should be read as a consistent direction of association across designs rather than as three estimates of one true effect size. The National Readmissions Database captures administrative diagnosis and procedure codes, not hemodynamic severity, shock stage, or the clinical reasoning behind a transfer decision, limiting how completely adjustment can address confounding by indication in that analysis [17]. The cost-effectiveness estimate for shock-team care [19] is conditional on the underlying observational effect being causal, a premise this review has argued cannot yet be confirmed. Finally, no attempt is made here to adjudicate between the specific mechanistic contributions of hemodynamic profiling, device escalation and transfer speed to any observed benefit; the evidence to do so does not yet exist in a form this review could responsibly synthesise.

Conclusion

Shock teams and regionalized hub-and-spoke networks are associated with better outcomes across every observational design that has examined them, and that consistency, together with the practical near-impossibility of a cluster-randomized alternative, is good reason to keep building both [10,11,17]. It is not yet evidence that the multidisciplinary team structure itself, rather than the standardized pathway of hemodynamic profiling, faster device escalation and protocolized transfer that a team reliably produces, is the causal ingredient. The device trials that do carry randomized evidence have been evenly split between benefit and futility [5-8], a useful reminder that plausible organizational reform, like plausible technology, still needs to be tested rather than simply adopted. A shared shock-team registry and prospective evaluation of the pathway's individual components, not just its bundled whole, are the field's most useful next step.

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