Effectiveness of the Shock Team on Short-Term Outcomes in Patients With Cardiogenic Shock
— Systematic Review and Meta-Analysis —

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Background: Recently, shock teams have been introduced to optimize cardiogenic shock (CS) care; however, their clinical benefits remain unclear. We conducted a systematic review and meta-analysis to assess whether management by a shock team improves outcomes in patients with CS.

Methods and Results: This meta-analysis was conducted according to the PRISMA guidelines. Studies comparing adults with CS managed with or without a shock team were identified from the PubMed, Web of Science, and Cochrane Library databases. The primary outcome was short-term mortality (cardiac intensive care unit, in-hospital, or 30-day mortality); the secondary outcome was bleeding. Of the 7 retrospective cohort studies that met the inclusion criteria, 3 without a critical risk of bias were included in the analysis. Shock team management was significantly associated with lower short-term mortality (odds ratio [OR] 0.52; 95% confidence interval [CI] 0.32–0.85; P=0.010) and bleeding complications (OR 0.62; 95% CI 0.43–0.91; P=0.010). Sensitivity analysis using crude data also supported the mortality benefit (OR 0.68; 95% CI 0.54–0.85; P<0.010). However, no randomized trials were included, and the certainty of evidence was rated very low owing to the risk of bias and inconsistency.

Conclusions: Shock team management may improve short-term outcomes in patients with CS; however, the level of evidence is very low. Further prospective studies are needed to evaluate optimal shock team composition and roles.

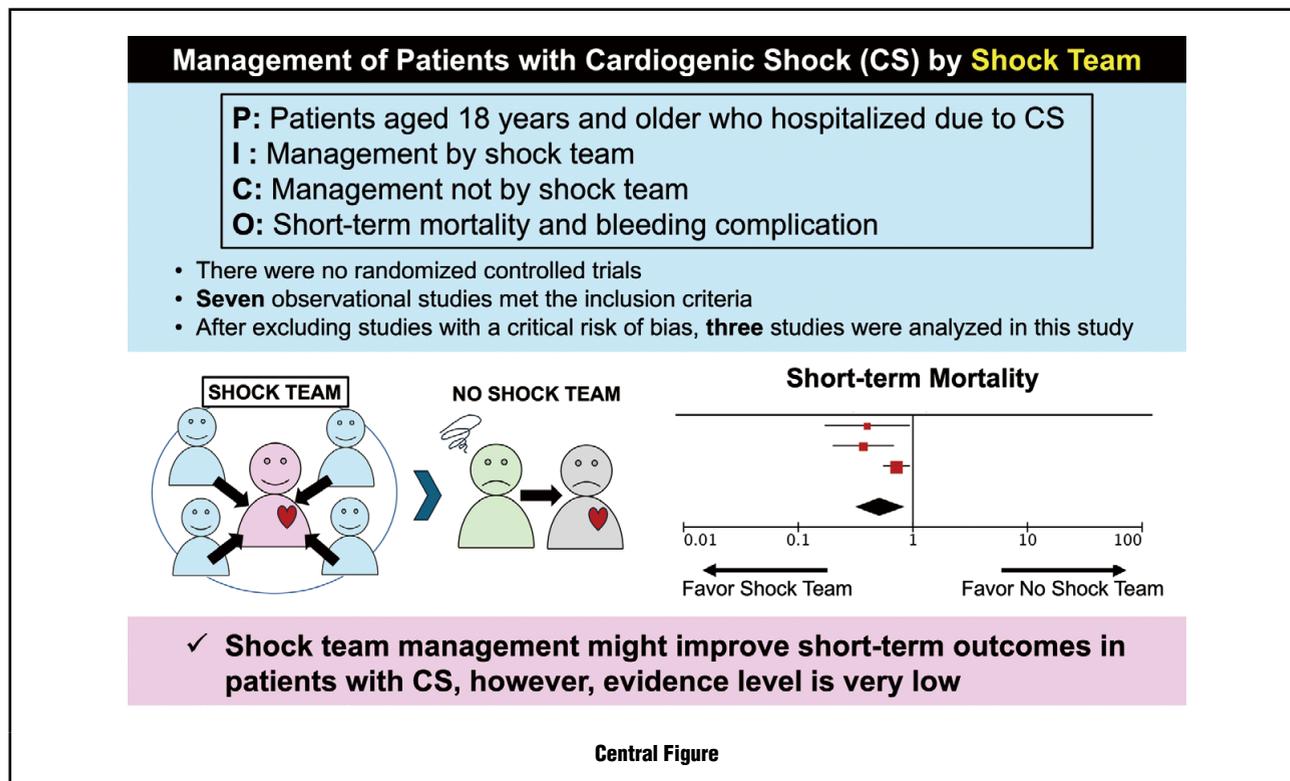**Key Words:** Acute myocardial infarction; Cardiogenic shock; Mechanical circulation support; Shock team

Cardiogenic shock (CS) is a hemodynamically complex condition of the heart characterized by reduced cardiac output and resulting in life-threatening hypoperfusion of multiple organs.[1,2] Despite advances in our understanding of the disease and its treatment, the mortality of patients with CS remains high.[3–8]

Among the various causes of CS, acute myocardial infarction (AMI) is one of the most common, and primary percutaneous coronary intervention is a well-established treatment that improves the survival rate of patients with AMI-CS.[9–12] However, previous studies have revealed that the mortality rate of AMI with CS is as high as 30–42% in

Central Figure

Japan.[3,13–15] Mechanical circulatory support (MCS) is also considered vital for treating patients with CS.[16–21] Shock teams have recently attracted attention in this field because they are effective in the rapid evaluation of and optimizing treatment for CS.[4,18] In addition, Tehrani et al. suggested that a hub-and-spoke network of shock care and multidisciplinary shock teams would contribute to the development of a regional system of CS care.[4] Specifically, a shock team is a multidisciplinary team consisting of an interventional cardiologist, cardiac surgeon, anesthetist, and other specialists who use protocols to perform initial assessments of patients with CS and discuss treatment options, including the use of MCS. Although the organization of and management by shock teams vary widely among institutions, several single-center studies have reported that shock team care is associated with a favorable prognosis in patients with CS.[22–27] Therefore, the aim of the present study was to clarify whether management by a shock team is associated with better survival outcomes in patients with CS.

Methods

Study Design

The Japan Resuscitation Council (JRC) CS Task Force for the 2025 JRC guidelines was established by the Japanese Circulation Society (JCS), the Japanese Association of Acute Medicine, and the Japanese Society of Internal Medicine. The research question investigated in this study was "What is the effect of a shock team on outcomes in patients with CS?" Based on discussions between the JRC CS Task Force and Guidelines Editorial Committee, the research question was posed using the Population, Intervention, Comparators, Outcomes, Study designs, and Time frame (PICOST) format, as follows:

P (population): patients aged ≥18 years who are hospitalized due to CS

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Figure 1. PRISMA flow diagram. CENTRAL, Cochrane Central Register of Controlled Trials.

Figure 2. Risk of bias summary for short-term mortality. (**A**) Traffic light plots. (**B**) Weight summary plots for short-term mortality were evaluated using adjusted odds ratios.
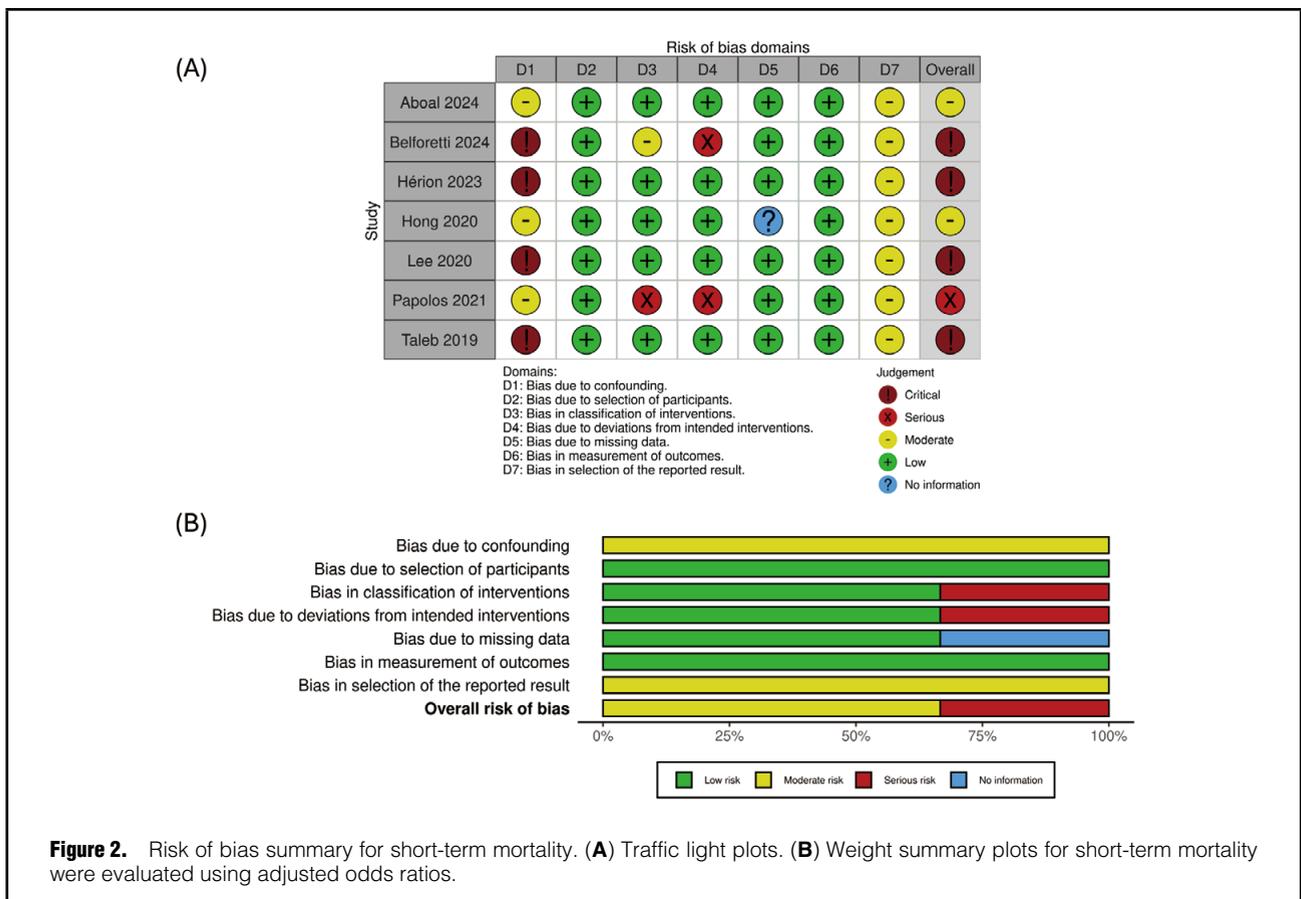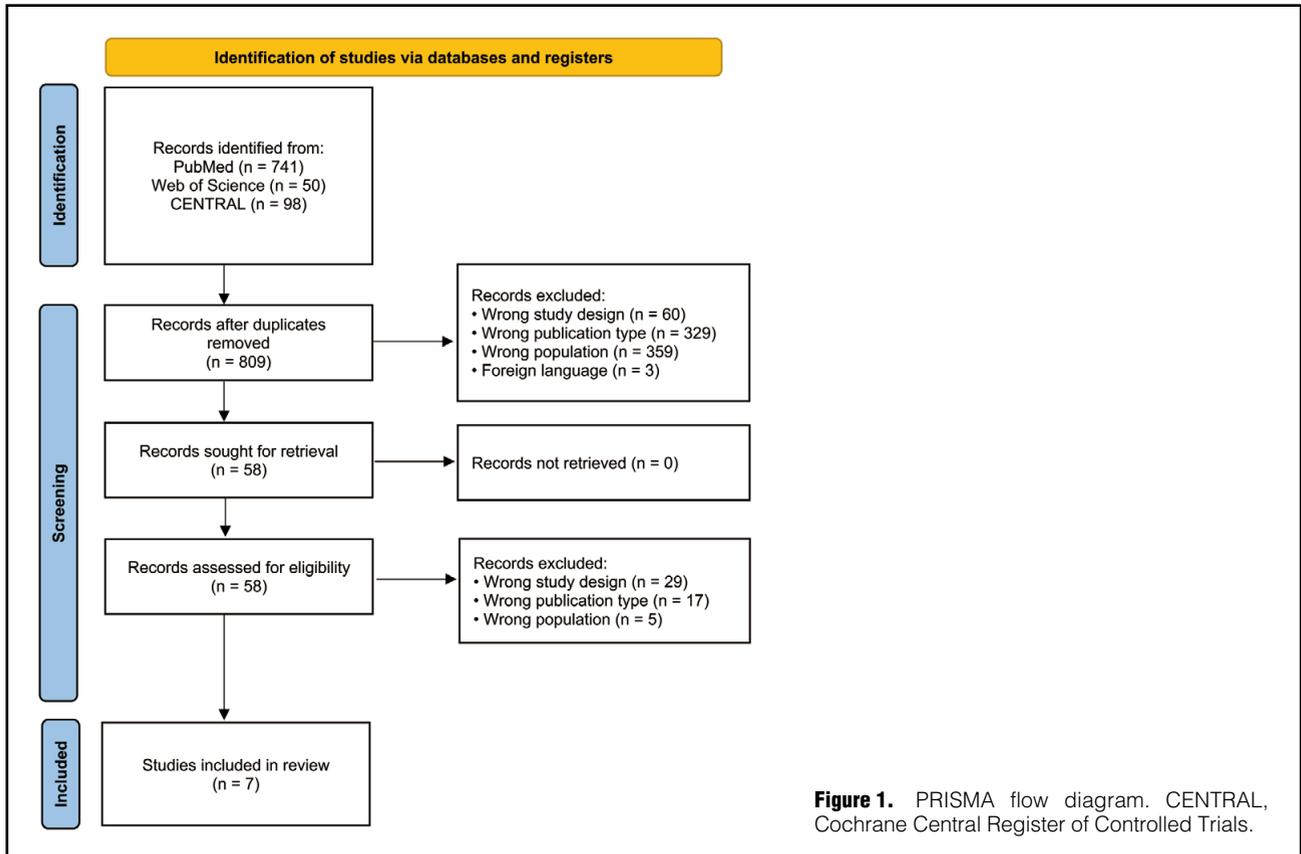
Table 1. Summary of the Included Studies

Author	Year	Country	Study design	Observation period	No. patients (shock team/no shock team)	Population	Interventions (shock team)	Control (no shock team)
Aboal et al.[22]	2024	Spain	Retrospective study comparing 2 periods in a single center	2017–2019	70/69	Single-center cohort	CS program period: management by 24-h acute cardiac care specialist and shock team, the use of short-term VA-ECMO, and query and transfer to transplant hospital	Previous period: management by acute cardiac care specialist during working hours without shock team
Hong et al.[25]	2020	Korea	Retrospective study comparing 2 periods in a single center	2004–2018	124/131	Single-center cohort	Post-ECMO team group: management by 24-h on-call team members with ECMO protocols	Pre-ECMO team group: attending physician responsible for running ECMO without ECMO protocols
Papolos et al.[34]	2021	US and Canada	Retrospective study comparing centers with vs. without shock teams	2017–2019	546/696	Multicenter registry (CCCTN)	Shock team group: treatment at centers having shock team	No shock team group: treatment at centers without shock team

ABP, arterial blood pressure; AMI, acute myocardial infarction; CCCTN, Critical Care Cardiology Trials Network; CICU, cardiac intensive care unit; CS, cardiogenic shock; ECMO, extracorporeal membrane oxygenation; SBP, systolic blood pressure; VA-ECMO, veno-arterial extracorporeal membrane oxygenation.

I (intervention): managed by a shock team
C (comparators/controls): not managed by a shock team
O (outcomes): cardiac intensive care unit (CICU) mortality, in-hospital mortality, or 30-day mortality, as well as bleeding complications
S (study designs): observational studies (there were no randomized controlled trials)
T (time frame): all literature published up to June 11, 2024.
The study protocol was registered with PROSPERO (CRD42024574229). This systematic review and meta-analysis was conducted in accordance with the PRISMA guidelines.[28,29]

Search Strategy
We conducted a comprehensive electronic search of the PubMed (MEDLINE and PubMed Central), Web of Science Core Collection (Science Citation Index – Expanded Since 1973), and Cochrane Central Register of Controlled Trials (CENTRAL) databases using terms identified by the review team up to June 11, 2024. The full search strategy is described in the **Supplementary Methods**. The search included all studies published in English; however, Japanese articles without an English abstracts were excluded.

Study Selection
Once duplicates were removed, 2 authors (M.A., T.K.) independently screened the study titles and abstracts for eligibility (first screening). After excluding case reports, case series, reviews, guidelines, animal studies, and studies that did not clearly report original human clinical data regarding the primary review question, the same authors (M.A., T.K.) independently evaluated the full text of potentially eligible articles against the inclusion and exclusion criteria (second screening). Any disagreements were resolved through discussion and final adjudication by a third independent author (T. Nakashima). The primary (critical) outcome was short-term mortality (i.e., CICU mortality, in-hospital mortality, or 30-day mortality), and the secondary outcome was bleeding complications.

Risk of Bias Assessment
The risk of bias in all included studies was independently evaluated by 2 authors (M.A., T.K.) according to the Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I).[30] All studies were assessed for bias in 7 domains, with the overall risk of bias categorized as being "low," "moderate," "serious," "critical", or "no informa-

Author	Definition of CS	Cause of CS	Management based on a protocol	Definition of shock team	Shock team vs. no shock team cohorts		
					Age (years)	% Male	Outcome measures (%)
Aboal et al.[22]	Mean ABP <70 mmHg maintained for >30 min, the need for vasopressor or inotropic drugs for >30 min, and signs of poor peripheral perfusion or serum lactate levels >15 mg/dL	Non-specific	Unknown	Cardiac surgeons, interventional cardiologists, and acute cardiac care cardiologists The shock team met urgently to assess the management of each patient If a patient was transferred from outside the hospital, all relevant specialists were immediately contacted via a group call	Mean 67.0 vs. 65.8	74.3 vs. 69.6	In-hospital mortality: 37.1 vs. 55.1 Bleeding: 17.1 vs. 21.7
Hong et al.[25]	Persistent hypotension (SBP <90 mmHg) for 30 min or a state that required inotrope or vasopressor support to achieve SBP >90 mmHg despite adequate filling status, with signs of hypoperfusion	AMI	ECMO criteria	ECMO team, comprising interventional cardiologists, critical care physicians, cardiovascular surgeons, heart failure physicians, a pharmacist, a nutritionist, and perfusionists who were formal intensive care registered nurses and received specific ECMO training	Mean 64.7 vs. 63.4	76.6 vs. 80.2	CICU mortality: 30.6 vs. 51.9 In-hospital mortality: 33.9 vs. 54.2 Major bleeding: 14.5 vs. 22.9
Papolos et al.[34]	Sustained hemodynamic impairment (i.e., SBP <90 mmHg or the need for inotropic or vasopressor support) with evidence of end organ hypoperfusion determined to be due to a primary cardiac etiology	Non-specific	Unknown	Self-identified as having established shock teams	Median 65 vs. 63	64.3 vs. 68.5	CICU mortality: 23.1 vs. 28.7

tion". Any disagreements were resolved through discussion and final adjudication by a third independent author (T. Nakashima). Studies judged to have a critical risk of bias were excluded from the meta-analysis.

Rating the Certainty of Evidence
The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) tool was used to rate the certainty of evidence on the effect of management by a shock team in patients with CS.[31,32] The certainty of the evidence was rates as "high," "moderate," "low," or "very low" according to the risk of bias, inconsistency, indirectness, imprecision, and publication bias.

Statistical Analysis
The results were summarized using a random-effects model to estimate the associations between shock team management and the outcomes. Dichotomous outcomes are described as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical heterogeneity between trials for each outcome was evaluated using the I^2 statistic to quantify inconsistencies,[33] which were considered significant if the reason for heterogeneity could not be explained and the I^2 was ≥50%. In the sensitivity analysis, we assessed studies in which crude ORs were available. The potential for publication bias was assessed using funnel plots. Statistical analyses were performed using RevMan 5.4.1 (The Nordic

Cochrane Centre, Copenhagen, Denmark), and P<0.05 (two-tailed) was considered to indicate a statistically significant difference.

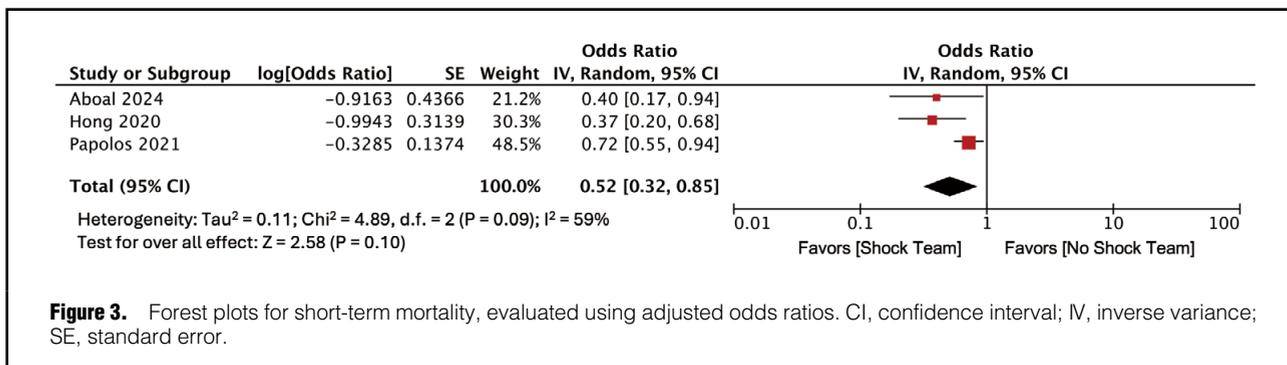## Results

Study Selection
Figure 1 shows a flow diagram of the study adapted from the PRISMA statement.[28,29] Our search retrieved 741 items from PubMed, 50 items from Web of Science, and 98 items from CENTRAL. After excluding duplicates, 809 studies were assessed for eligibility based on their titles and abstracts as part of the first screening. After excluding 751 studies in the first screening and 58 studies in the second screening, 7 retrospective cohort studies remained that met the inclusion criteria.[22–27,34] There were no randomized controlled trials (RCTs).

Risk of Bias
For the critical outcome of short-term mortality, 2 studies were judged to have a moderate overall risk of bias,[22,25] 1 was judged to have a serious overall risk of bias,[34] and 4 were judged to have critical overall risks of bias[23,24,26,27] (**Figure 2**). After excluding the studies with a critical overall risk of bias, 3 studies were left for analysis.[22,25,34] All 3 were included for the analysis of the secondary outcome of bleeding. All 3 studies only described crude data; therefore,

Figure 3. Forest plots for short-term mortality, evaluated using adjusted odds ratios. CI, confidence interval; IV, inverse variance; SE, standard error.

Table 2. Evidence Profile of Short-Term Mortality

No. studies	Study design	Certainty assessment				
		Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias
3	Observational studies	Serious	Serious	Not serious	Not serious	Not serious

No. studies	No. patients (%)		Effect		Certainty	Importance
	Shock team	No shock team	Relative (95% CI)	Absolute		
3	194/630 (31)	309/896 (34)	OR 0.52 (0.32–0.85)	NA	Very low	Critical

CI, confidence interval; OR, odds ratio.

they were judged to have a critical overall risk of bias (**Supplementary Figure 1**). Bleeding outcomes were analyzed using crude data.

Study Characteristics

The characteristics of the studies included in this review are summarized in **Table 1**. Of the 3 studies included in the meta-analysis, 2 compared the periods before and after the establishment of a shock team at a single institution,[22,25] and the remaining study compared institutions with and without a shock team.[34] The median or mean age of patients in the included studies managed by a shock team ranged from 64.7 to 67.0 years, compared with 63.0–65.8 years for patients who were not managed by a shock team. Regarding study populations, 2 studies included patients with CS,[22,34] with the third study including patients with CS after AMI.[25] The crude short-term mortality rate ranged from 26% to 46%. All 3 studies examined the occurrence of bleeding complications,[22,25,34] with the crude incidence of bleeding ranging from 17% to 33%. The definition of the shock team in each of the 3 studies is provided in **Table 1**.

Outcomes

For the critical outcome of short-term mortality, management by a shock team was associated with lower short-term mortality (i.e., CICU mortality, in-hospital mortality, or 30-day mortality) compared with no shock team management (OR 0.52; 95% CI 0.32–0.85; P=0.010; **Figure 3**). Visual inspection of funnel plots suggested no serious publication bias (**Supplementary Figure 2**). In the sensitivity analysis, patients managed by a shock team had lower crude short-term mortality than those not managed by a shock team (OR 0.68; 95% CI 0.54–0.85; P<0.010; **Supplementary Figure 3**). **Table 2** summarizes the evidence profile based

on the assessment of the certainty of evidence for short-term mortality. The certainty of evidence was rated as very low because of a serious risk of bias and a serious risk of inconsistency.

With respect to the secondary outcome of bleeding, patients managed by a shock team had a lower crude incidence of bleeding than those not managed by a shock team (OR 0.62; 95% CI 0.43–0.91; **Supplementary Figure 1**).

Discussion

This systematic review and meta-analysis showed that management by a shock team was associated with lower short-term mortality and incidence of bleeding than management without a shock team in patients with CS. No RCTs were included in the meta-analysis, and the certainty of the evidence was judged to be very low.

Recently, the management of patients with CS, including medical therapy and the use of MCS, has advanced. Therefore, medical staff involved in the management of CS are required to have extensive and updated knowledge and abundant experience.[4,18] The involvement of a shock team may influence the use of pulmonary artery catheters (PACs) and decisions regarding the use of MCS, affecting patient outcomes.[4] Aboal et al. reported that the rate of MCS use did not change from before to after the establishment of a shock team; however, the use of extracorporeal membrane oxygenation and combinations of MCS increased during the shock team period.[22] Some studies had protocols for selecting MCS,[22,24–26] and differences in institutional policies may also affect MCS selection. Unlike MCS, Papolos et al. reported that institutions with shock teams used PACs more frequently (60.4% vs. 49.0%; P<0.001) and advanced types of MCS, such as Impella® and TandemHeart®, but

used less MCS overall (advanced MCS, 53% vs. 43% [P=0.005]; overall MCS, 35% vs. 43% [P=0.016]).[34] This may be because PAC monitoring revealed the hemodynamic profile and severity of a patient's condition, which may affect MCS selection.[35–37] Kondo et al. reported that CS management with PACs was associated with better in-hospital mortality.[38] These authors encouraged the use of PACs as a useful tool to guide decision-making.[38]

Furthermore, studies have suggested that involving multidisciplinary experts in acute cardiovascular care as part of the shock team contributes to improved outcomes.[22,27,34] For example, interventional cardiologists, cardiac intensivists, cardiac surgeons, critical care physicians, heart failure physicians, and anesthetists were included as members of the shock team. Hong et al. considered that pharmacists and nutritionists also play an important role in adjusting medications and monitoring nutritional status during extracorporeal membrane oxygenation support.[25] We believe that having multidisciplinary experts with extensive knowledge and experience will help prevent delays in intervention, and ultimately may contribute to reduced mortality and bleeding events in patients with shock; however, the evidence is very uncertain. In addition, there is no consensus on team members and their roles. Therefore, future issues to be addressed include determining the optimal members and protocols of shock teams, the timing of shock team activating, and hospitals in which shock teams should be established.

Study Limitations
This study has some limitations. First, no RCTs were included in the study; therefore, it is difficult to discuss the causal relationship between the shock team and the prognosis of patients with CS. Further prospective RCTs are needed to provide robust evidence supporting our findings. Second, each study had a different definition of a shock team, and management with or without a protocol was not unified. This may have influenced the meta-analysis and is therefore an issue that needs to be resolved in the future. Third, the definition of bleeding incidence differed among studies. In addition, the incidence of bleeding was analyzed using crude data, which was assessed as a critical risk of bias.

Conclusions
This meta-analysis supports the management of patients with CS by a shock team. However, it should be noted that the quality of evidence for these findings was very low.

Disclosures
T. Matoba is a member of *Circulation Reports*' Editorial Team. The other authors declare no conflicts of interest regarding this article.

IRB Information
None.

Data Availability
All data used in this analysis were obtained from the PubMed, Web of Science Core Collection (Science Citation Index – Expanded Since 1973), and Cochrane Library (CENTRAL) databases.

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Supplementary Files

Please find supplementary file(s);
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