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Track 1A

Cardiology Critical Care



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Critical Care Cardiology Session

American College of Cardiology

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Session

Moderator: Jasdeep Dhaliwal, MD

Speakers: Vasili Katsadouros, DO, Sonu Abraham, MD, Siddarth Pahwa, MD, and Jeffrey Spindel, DO

Session Chair: Paul Anaya, MD PhD



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Agenda

2:05 PM Introduction

2:10-2:15 PM Case Presentation: A Shocking Success, Vasili Katsadouros, DO

2:15-2:25 PM Approach to the Patient with Cardiogenic Shock, Sonu Abraham, MD

2:30-2:40 PM Cardiogenic Shock: A Surgeon's Perspective, Siddharth Pahwa, MD

2:45-2:55 PM The Future of Critical Care Cardiology



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Trainee Presentation; Vasili Katsadourous



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A Shocking Success KY-ACC Critical Care

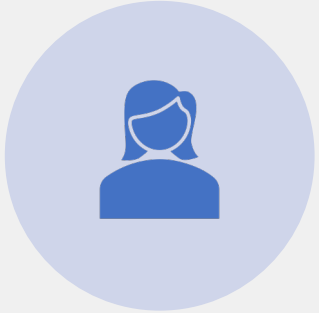
Vasili Katsadourous DO



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Our Case



33 y/o F – Hx of Hashimoto thyroiditis

Over last year, multiple symptoms limiting ADL/iADL
Week prior, symptoms of URI



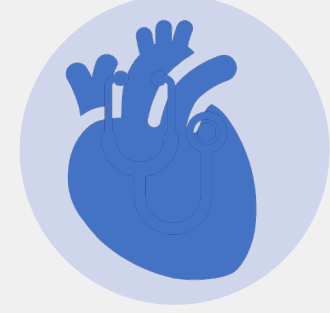
Presented to outside hospital with abdominal pain

Initial presentation concerning for shock
LVEF found to be under 20%



Required multiple inotropes and vasopressors

Refractory shock despite above interventions



She was then transferred to UK for further management

Clinical picture concerning for cardiogenic shock



Our Case

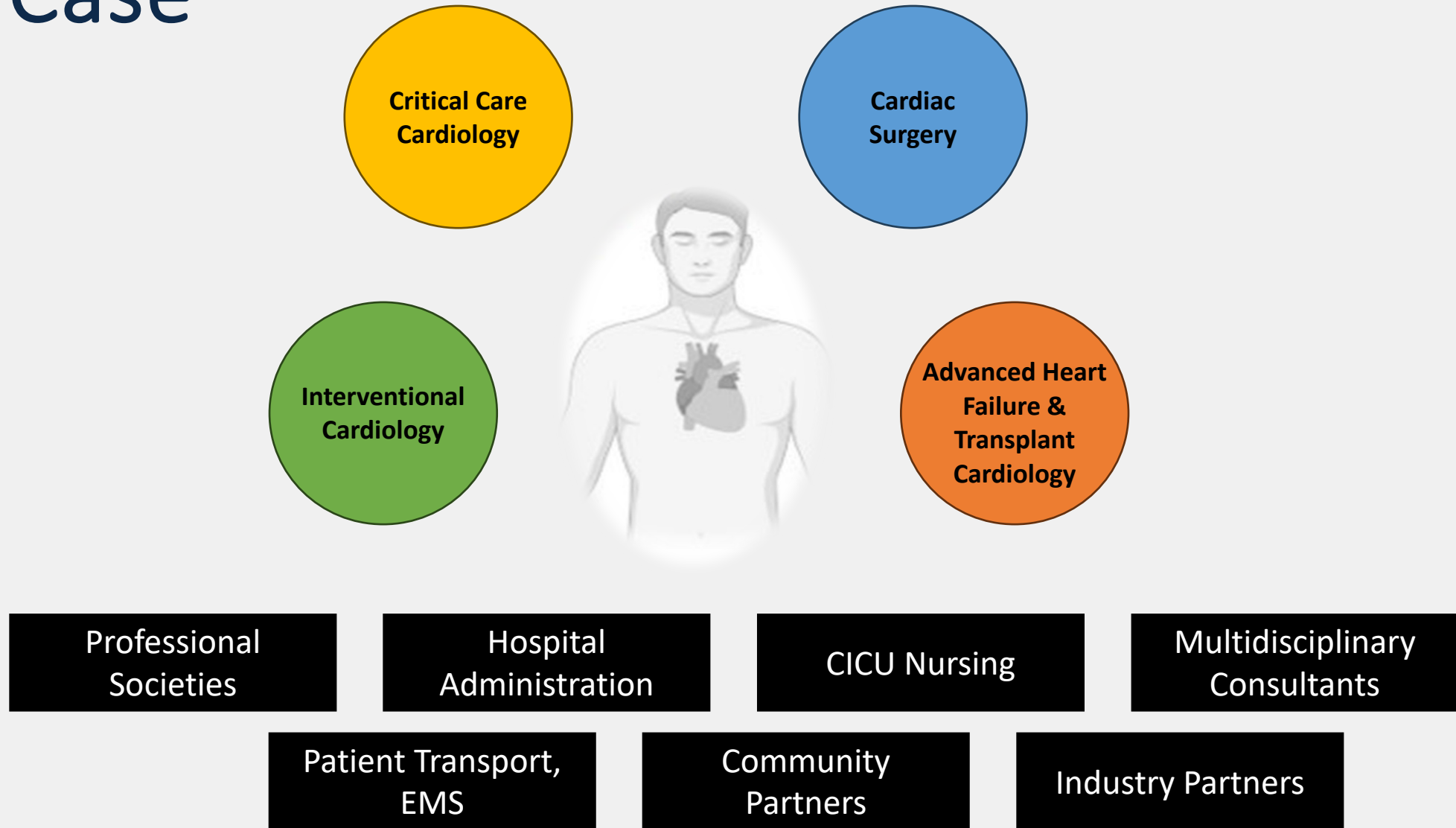
RHC

- RA 18,
- PA 35/20/28,
- PAWP 19,
- PA sat 56%,
- CO/CI Fick 3.95/2.3,
- PVR 2.25, SVR 1280 dynes,
- PAPi 0.83
- CPO 0.73
- CVP to Wedge 0.95

<u>Cardiogenic Shock Stage</u>	<u>Study Definition</u>
Stage A (" <u>A</u> t risk")	Neither hypotension/tachycardia nor hypoperfusion
Stage B (" <u>B</u> eginning")	Hypotension/tachycardia WITHOUT hypoperfusion
Stage C (" <u>C</u> lassic")	Hypoperfusion WITHOUT deterioration
Stage D (" <u>D</u> eteriorating")	Hypoperfusion WITH deterioration NOT refractory shock
Stage E (" <u>E</u> xtremis")	Hypoperfusion WITH deterioration AND refractory shock



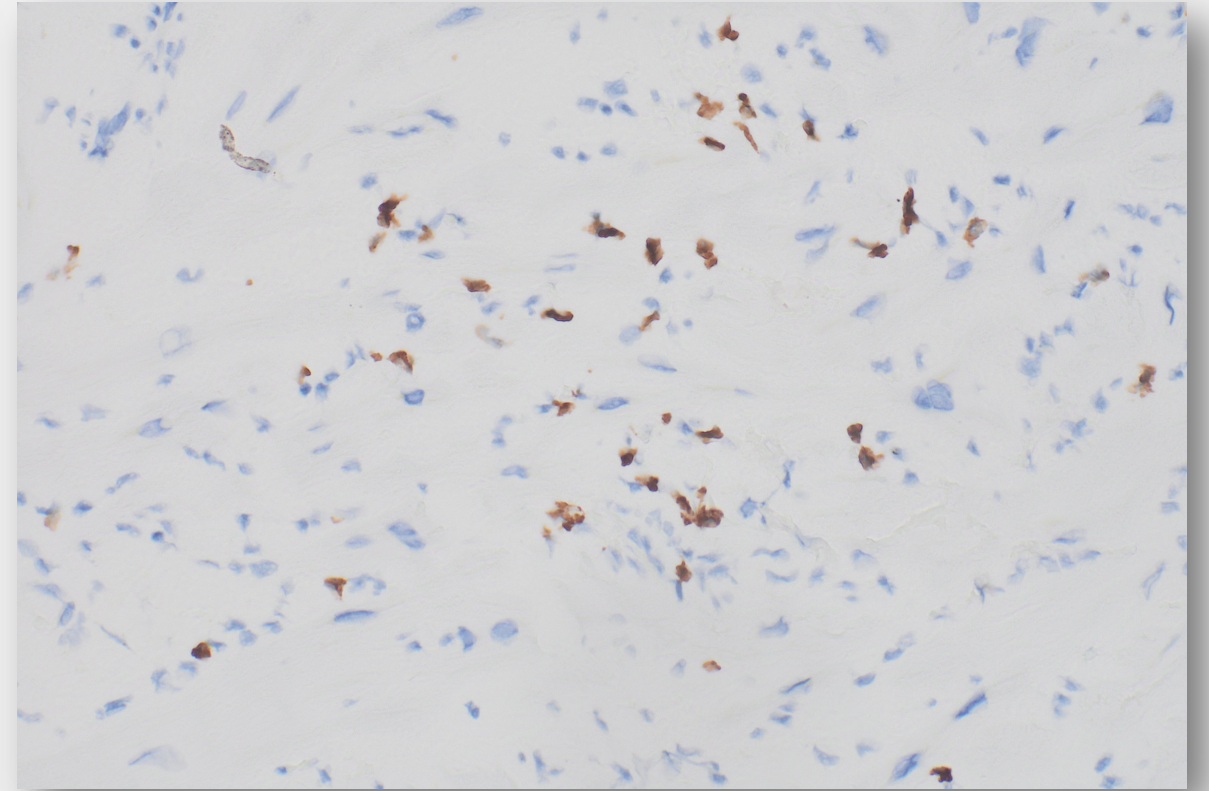
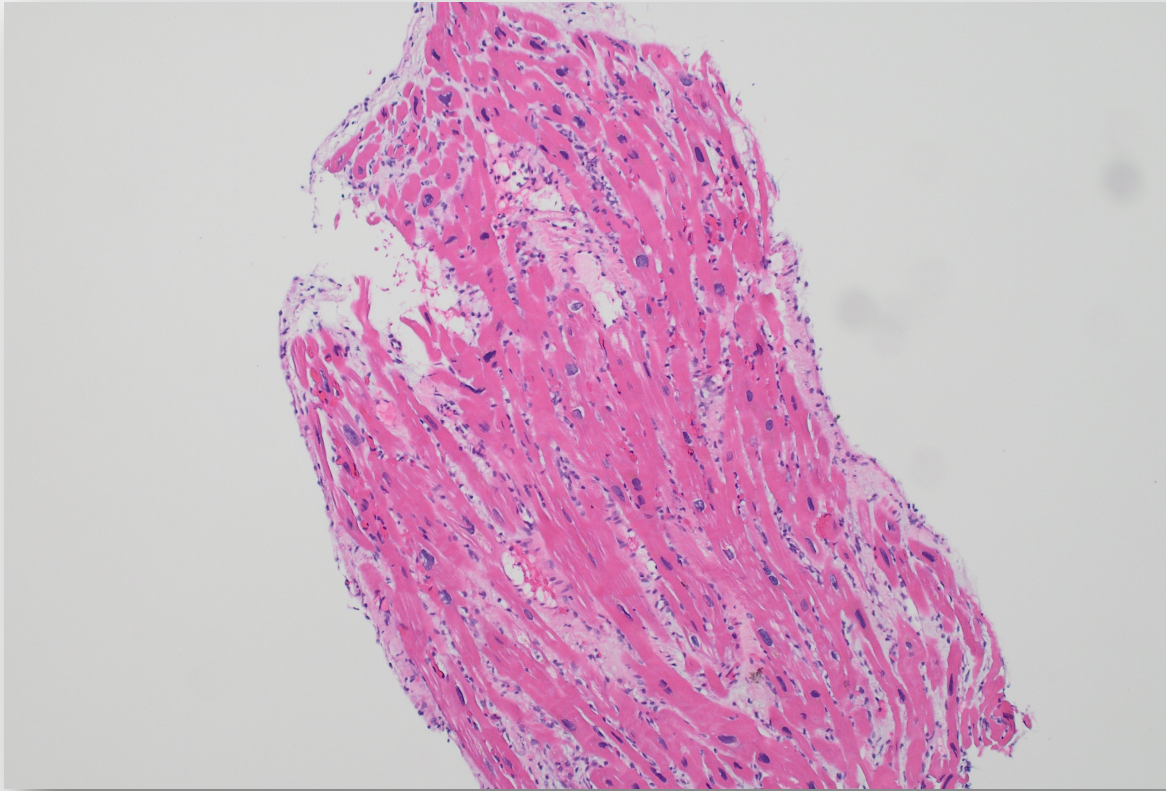
Our Case



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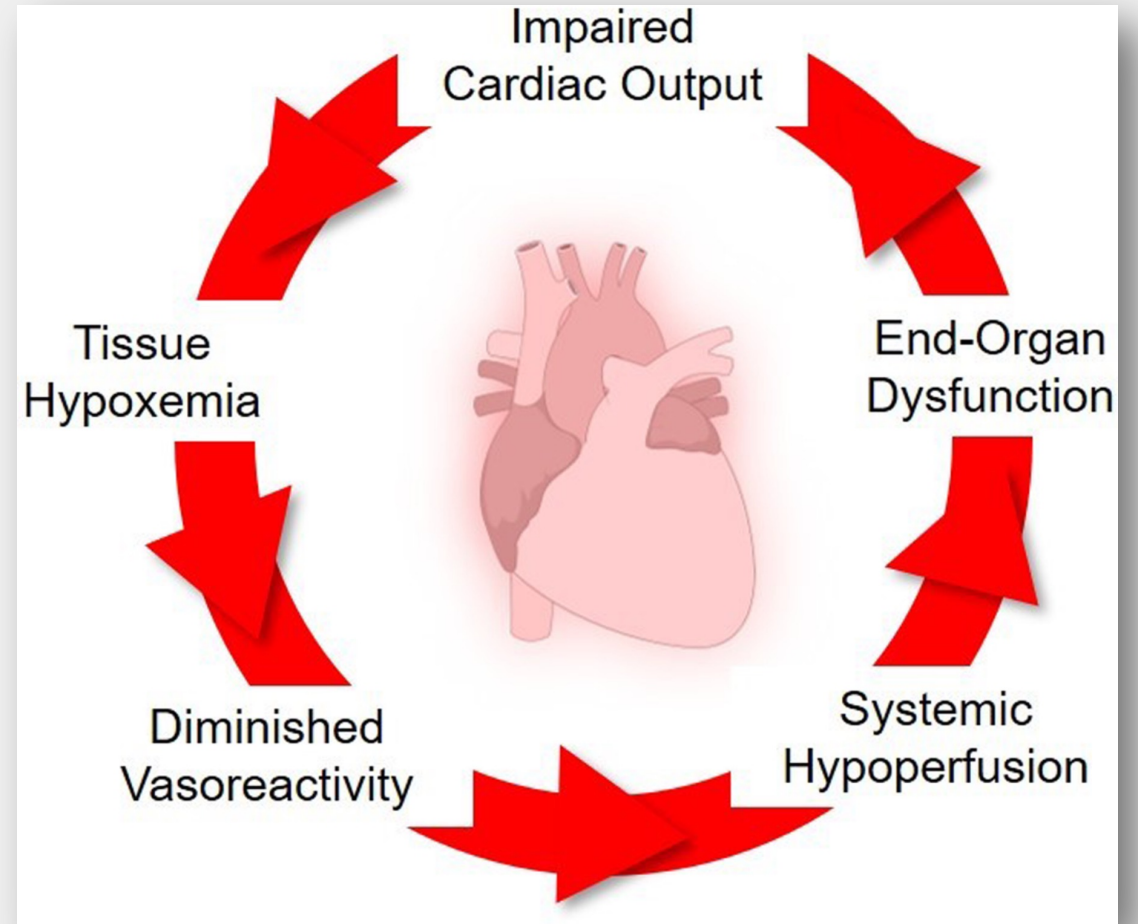
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EMB Results – Lymphocytic Myocarditis



Our Case – Unfolding the story

- Lymphocytic myocarditis
- Respiratory panel – (+) Rhinovirus
- Questionable underlying chronic cardiac dysfunction

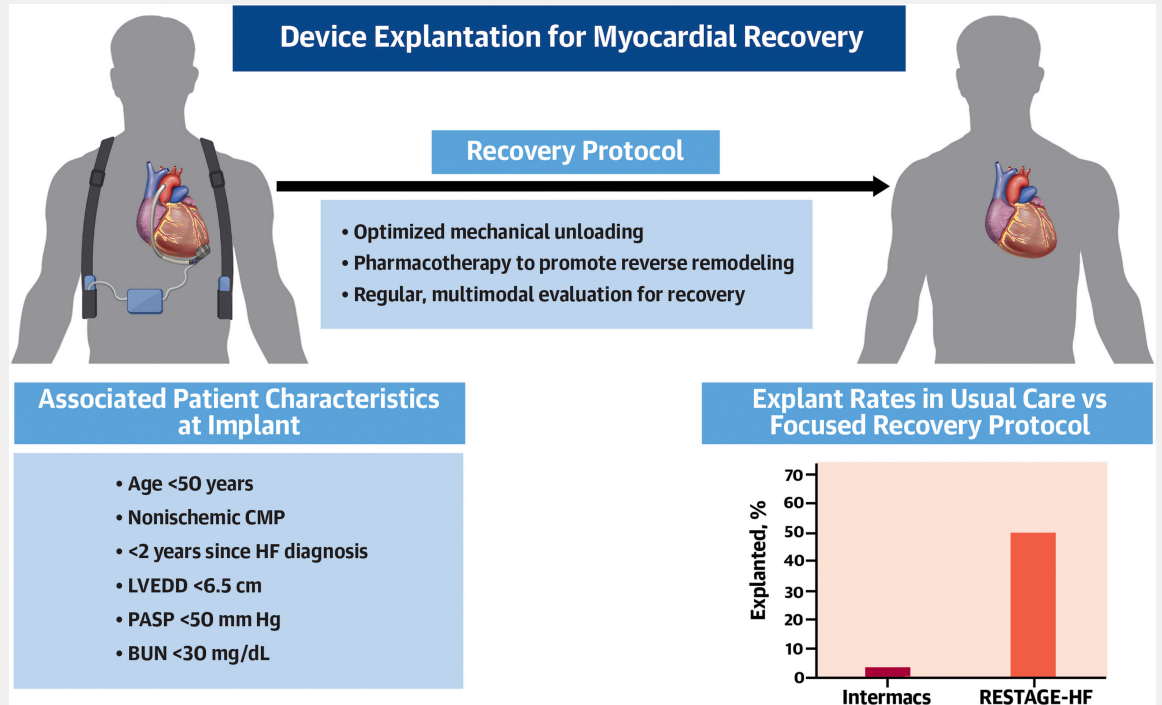


Our Case – Multi-disciplinary care

- Inability to wean support
- Permanent MCS VS Transplant
 - Potential for myocardial recovery
 - Young age
 - Positive QuantiFeron TB gold test
- Decision made for LVAD implantation

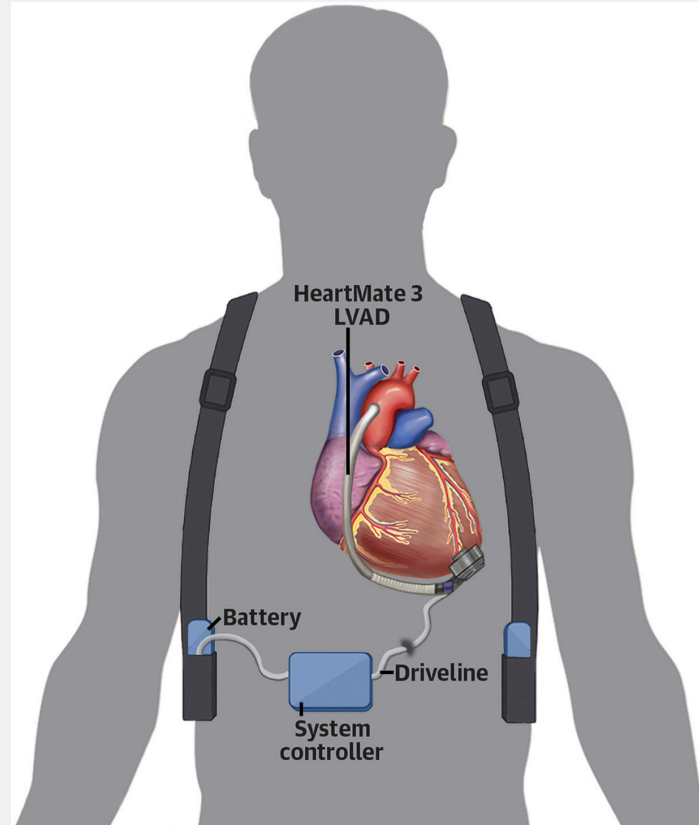
Prospective Multicenter Study of Myocardial Recovery Using Left Ventricular Assist Devices (RESTAGE-HF [Remission from Stage D Heart Failure])

Medium-Term and Primary End Point Results

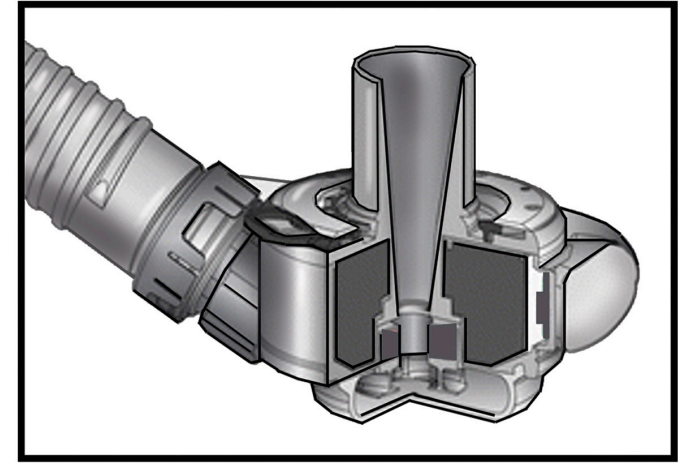


Our Case – Post VAD

- Post op course
 - -Complicated by...
 - Significant bleeding
 - RV failure
- Genetic Testing
 - HCM/DCM variant
- Myocardial recovery regimen
- Discharged home and doing well!



HeartMate 3 LVAD



- Intra-thoracic pump
- Improved coagulation system stability
- Fully magnetically levitated motor
- Artificial pulsatility
- Large blood flow pathways

Successful management of cardiogenic shock



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References

Senman B, Jentzer JC, Barnett CF, et al. Need for a Cardiogenic Shock Team Collaborative-Promoting a Team-Based Model of Care to Improve Outcomes and Identify Best Practices. *J Am Heart Assoc.* 2024;13(6):e031979. doi:10.1161/JAHA.123.031979

Jentzer JC, van Diepen S, Barsness GW, et al. Cardiogenic Shock Classification to Predict Mortality in the Cardiac Intensive Care Unit. *J Am Coll Cardiol.* 2019;74(17):2117-2128. doi:10.1016/j.jacc.2019.07.077

Varshney AS, DeFilippis EM, Cowger JA, Netuka I, Pinney SP, Givertz MM. Trends and Outcomes of Left Ventricular Assist Device Therapy: JACC Focus Seminar. *J Am Coll Cardiol.* 2022;79(11):1092-1107. doi:10.1016/j.jacc.2022.01.017



Talk 1: Sonu Abraham



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Cardiogenic Shock: An Update

Sonu Abraham, MD, FACC
Advanced Heart Failure & Transplant Cardiologist
Assistant Professor, Department of Medicine
Gill Heart & Vascular Institute
University of Kentucky



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Learning Objectives

Cardiogenic shock Definition, Staging and Classification

Pharmacological therapies for cardiogenic shock

Invasive therapies for cardiogenic shock

Utility of the Swan-Ganz Catheter



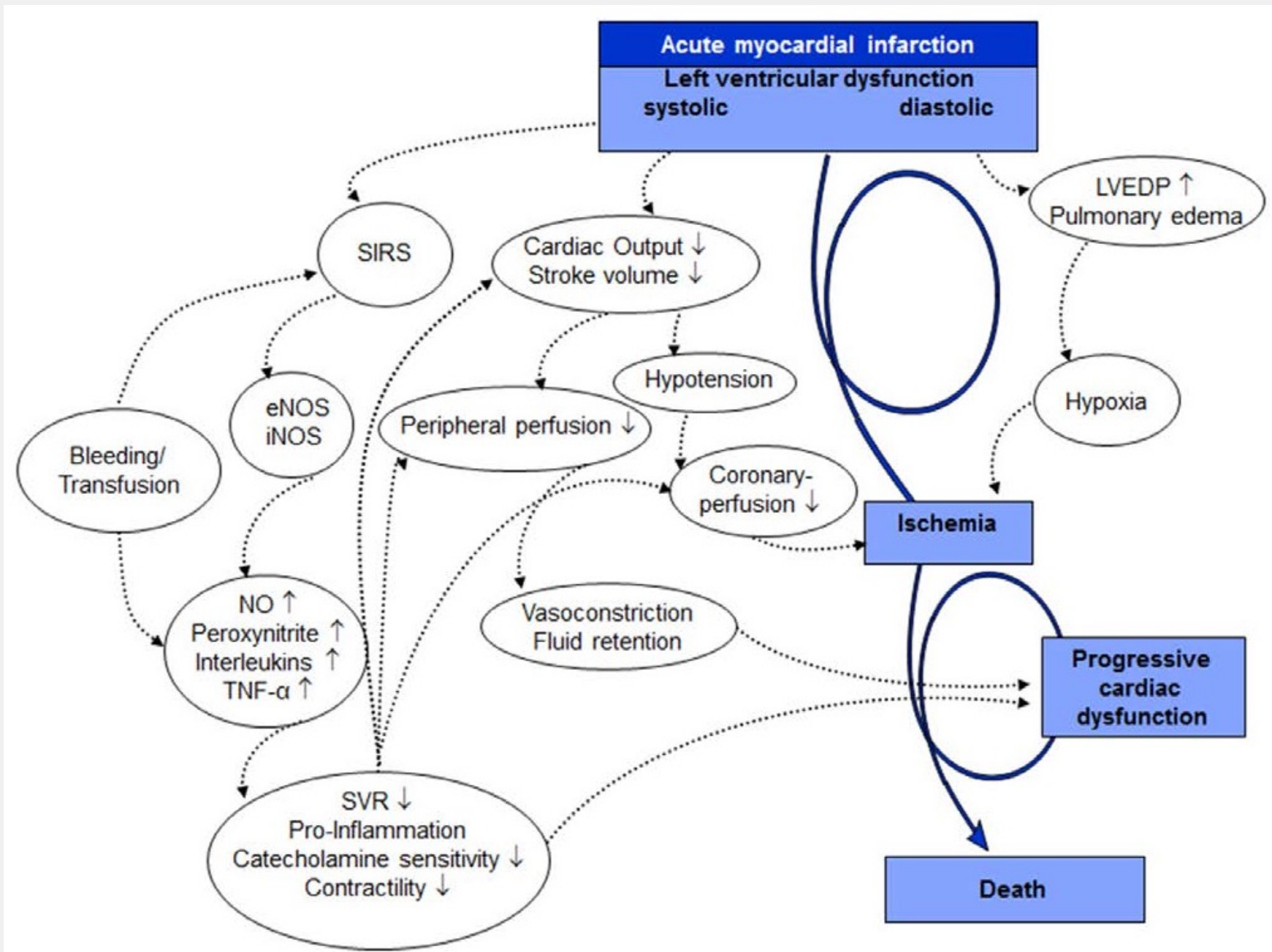
Cardiogenic Shock Definition, Staging and Classification



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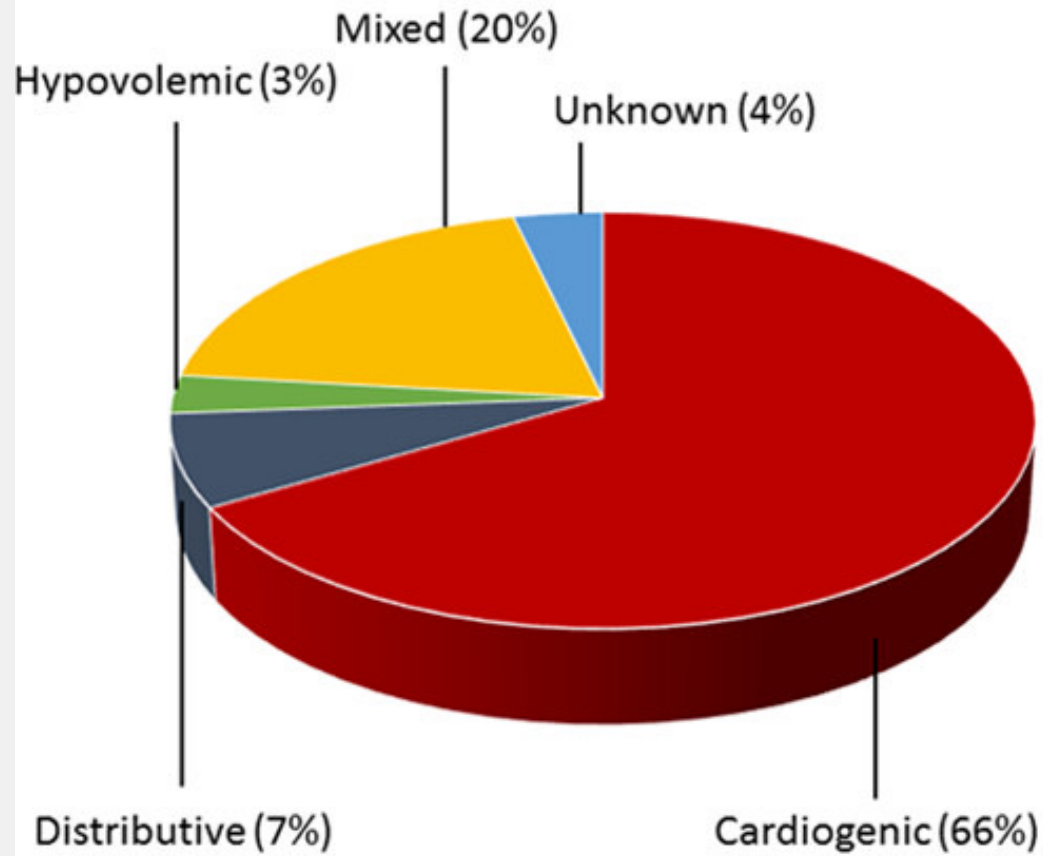
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Cardiogenic Shock Spiral

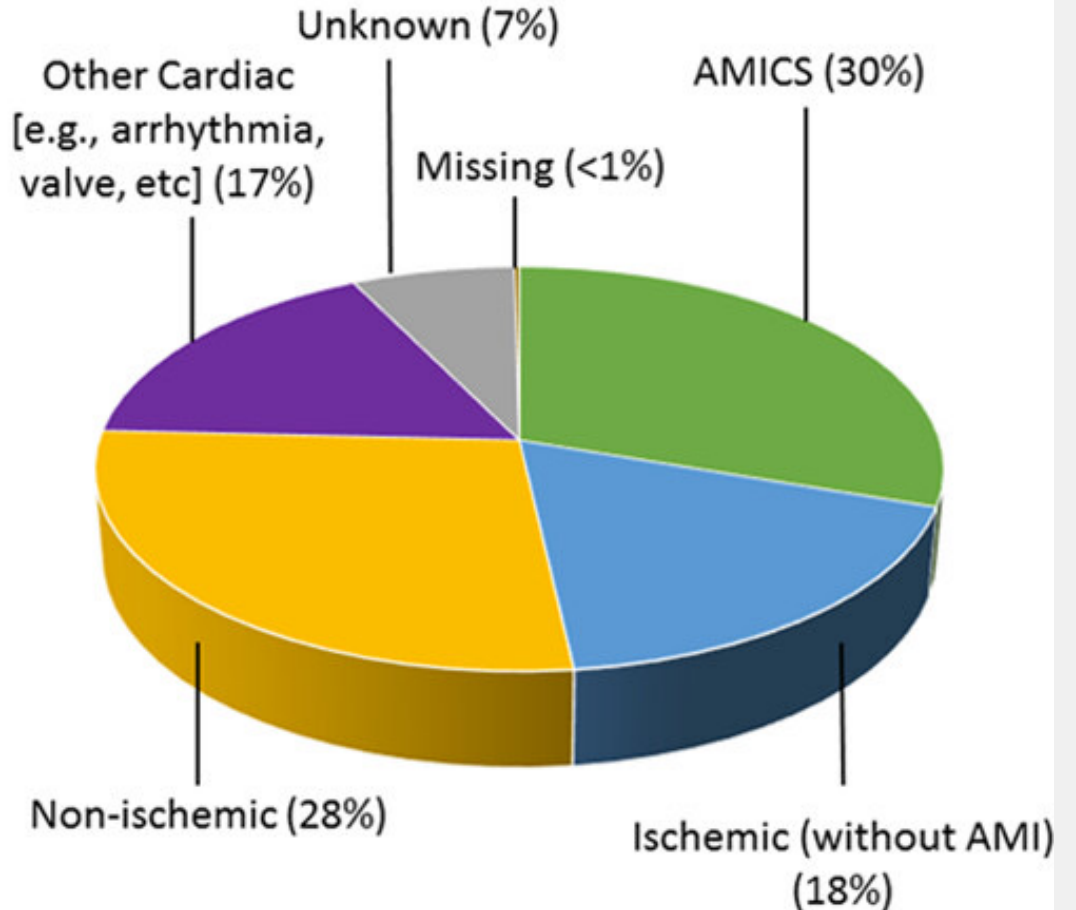


Heterogeneity of Cardiogenic Shock

A Etiology of Shock (N=677)



B Cause of Cardiogenic Shock (N=450)



Hemodynamic presentations of Cardiogenic Shock

		Volume Status	
		Wet	Dry
Peripheral Circulation	Cold	Classic Cardiogenic Shock (↓CI; ↑SVRI; ↑PCWP)	Euvolemic Cardiogenic Shock (↓CI; ↑SVRI; ↔PCWP)
	Warm	Vasodilatory Cardiogenic Shock or Mixed Shock (↓CI; ↓/↔SVRI; ↑PCWP)	Vasodilatory Shock (Not Cardiogenic Shock) (↑CI; ↓SVRI; ↓PCWP)

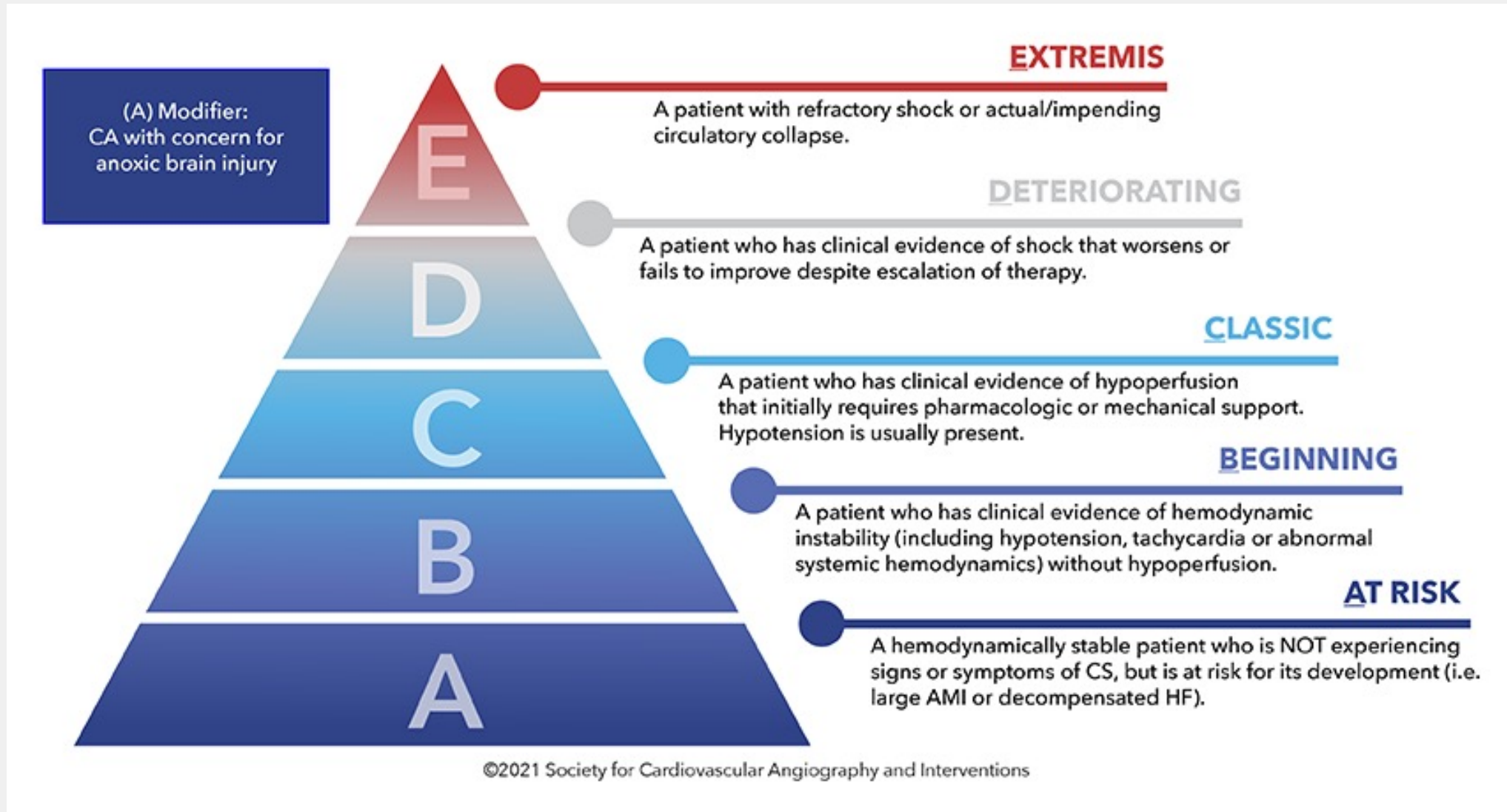
van Diepen S et al. *Circulation*. 2017;136(16):e232-e268.



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Modified SCAI Shock Stages



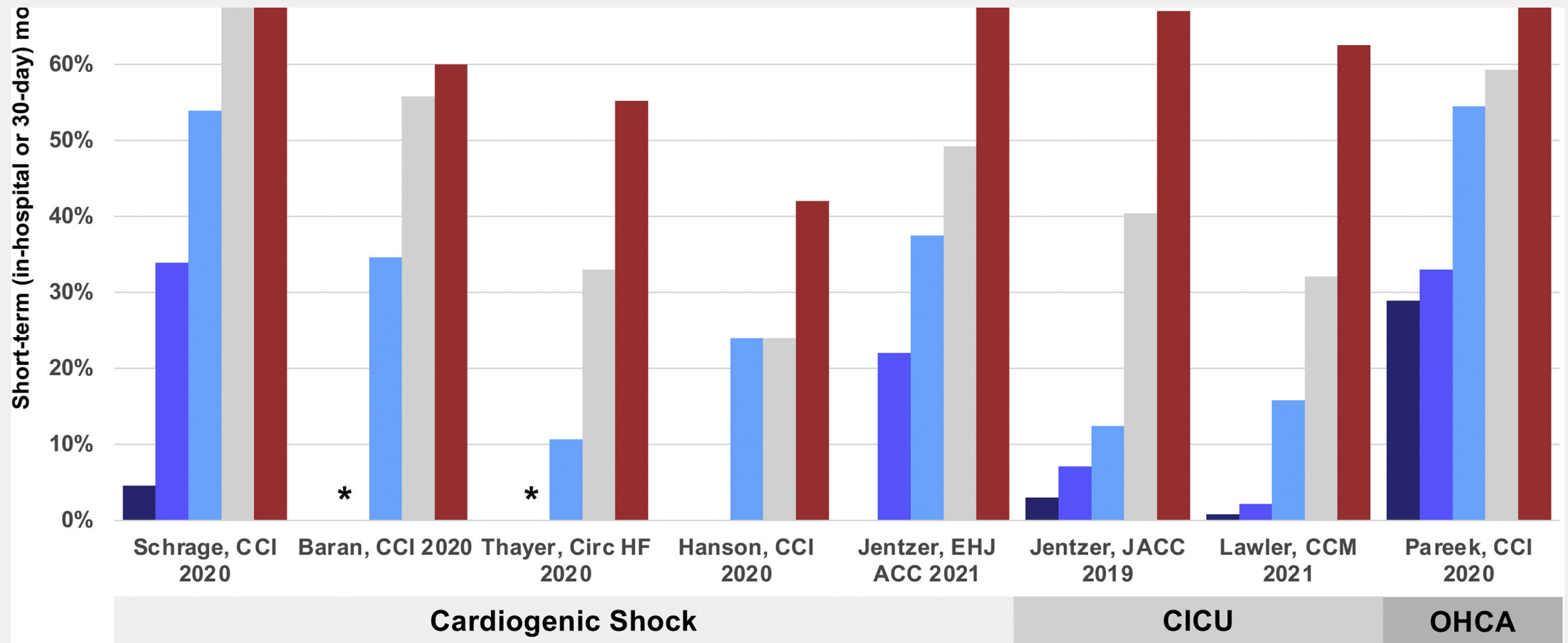
Naidu, Srihari S. et al. JSCAI, Volume 1, Issue 1, 100008

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Short-term mortality as a function of SCAI SHOCK stages



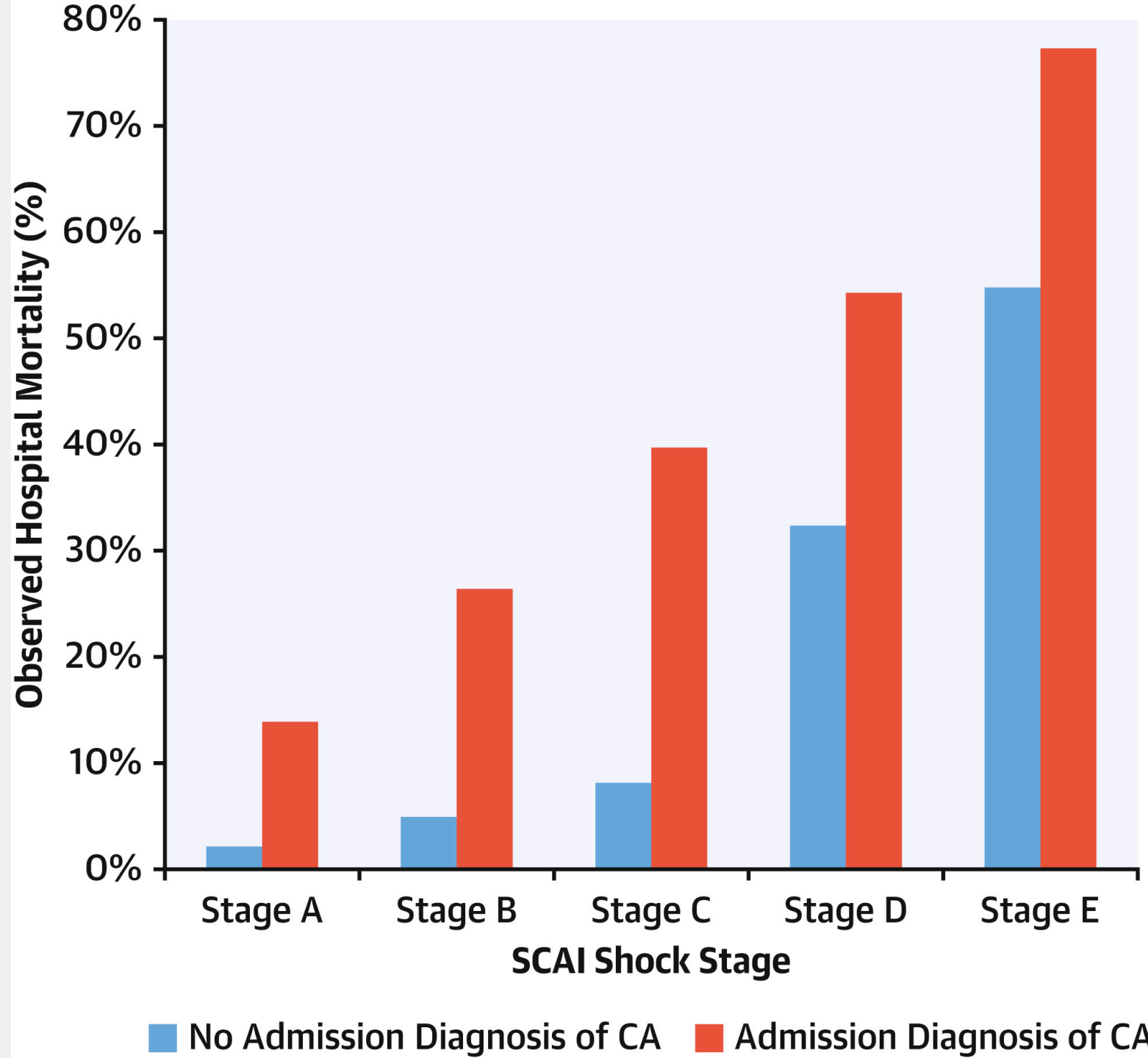
Naidu, Srihari S. et al. JSCAI, Volume 1, Issue 1, 100008

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Cardiac Arrest as a Shock Modifier



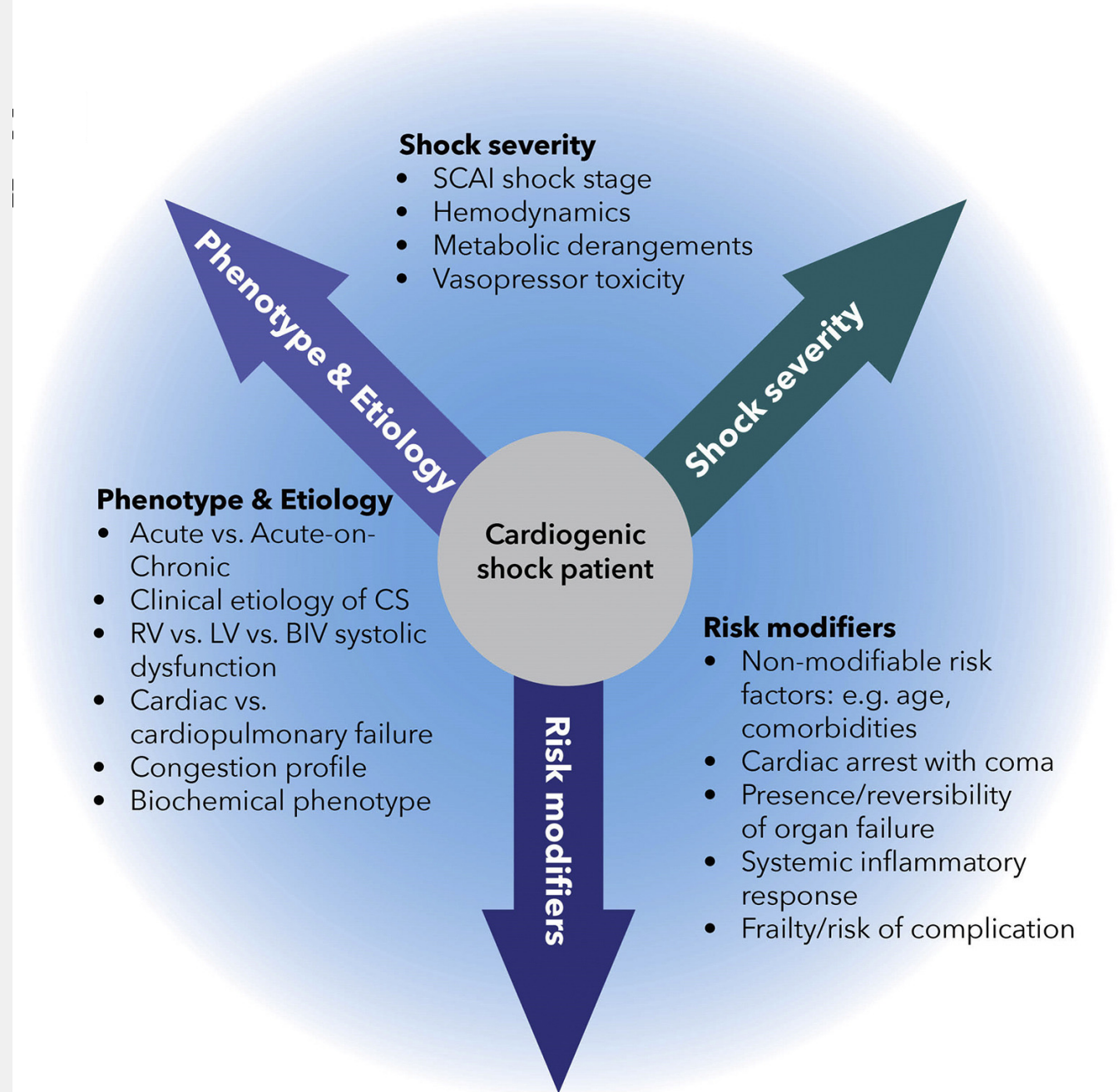
Jentzer, J et al. *JACC*. 2019 Oct, 74 (17) 2117–2128



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3-axis Model of Cardiogenic Shock Evaluation & Prognostication

Naidu, Srihari S. et al. JSCAI, Volume 1, Issue 1, 100008



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Chronic cardiovascular disease
SCAI shock stage not applicable

Acute cardiovascular event

Recovery

RECOVERY PATHWAYS

Normalization of perfusion metrics while on support (MCS or pharmacologic) improves to Stage C. If remains normal with removal of support, then improves to Stage B or A.

Hemodynamically stable
SCAI shock stage A

Loss of $\updownarrow$ compensation

Hemodynamically unstable
SCAI shock stage B

Loss of $\updownarrow$ compensation

Hypoperfusion = Shock
SCAI shock stage C

$\updownarrow$ Deterioration

Failure to stabilize with initial Tx
SCAI shock stage D

$\updownarrow$ Deterioration

Extremis / refractory shock
SCAI shock stage E

DETERIORATION PATHWAYS

Acute catastrophic event (i.e., prolonged CA) arrives in Stage E. All others must stop at least transiently in Stage C for first intervention.

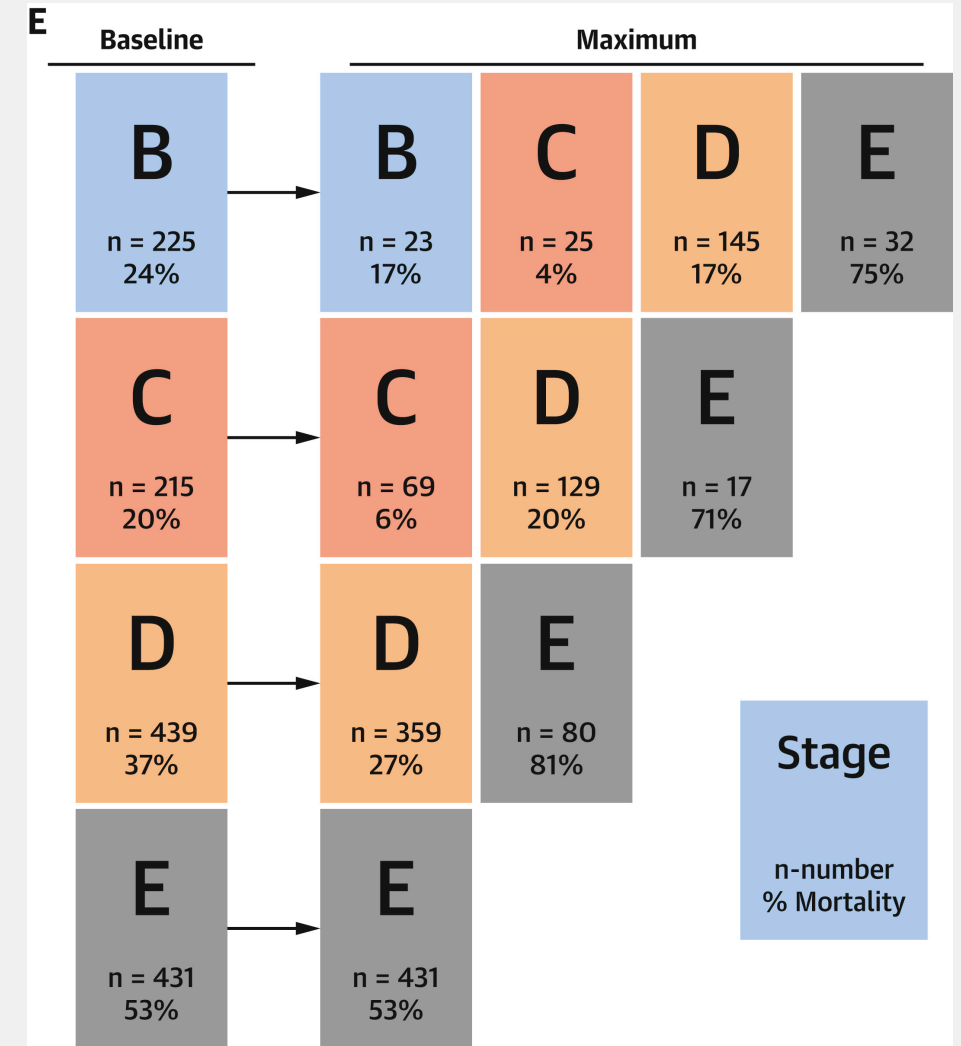
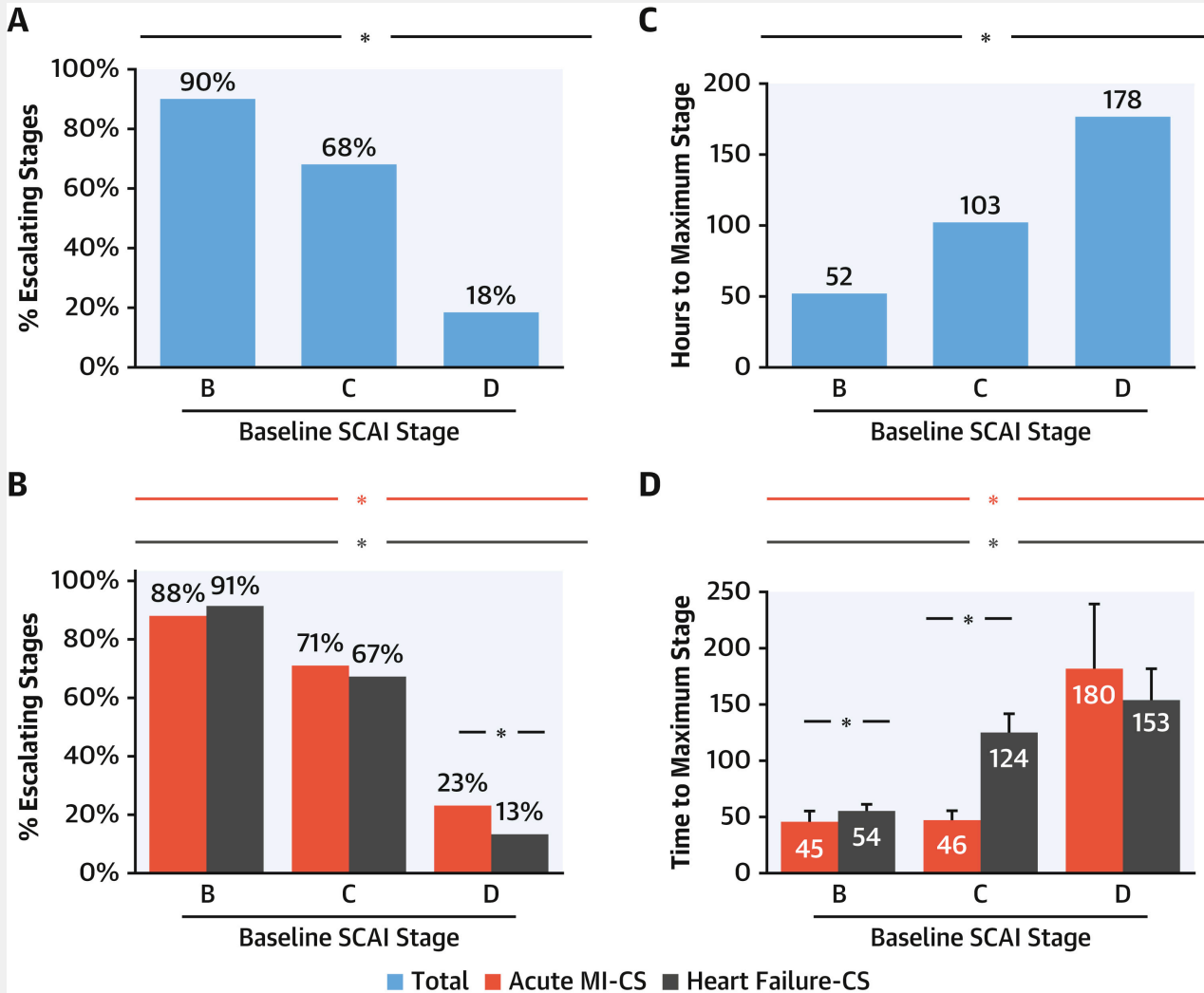
Naidu, Srihari S. et al. JSCAI, Volume 1, Issue 1, 100008

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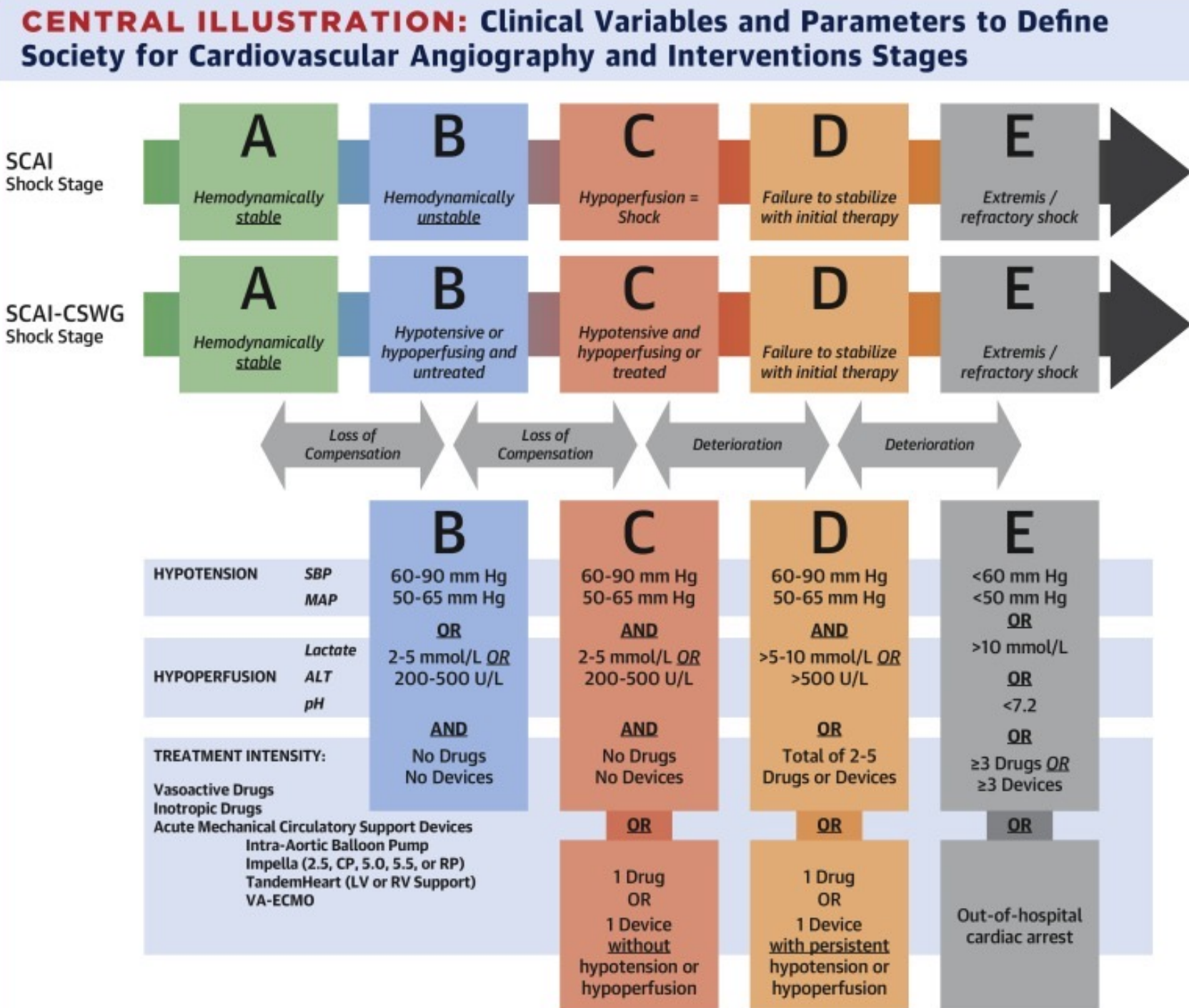


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Dynamic Escalation of CS stages

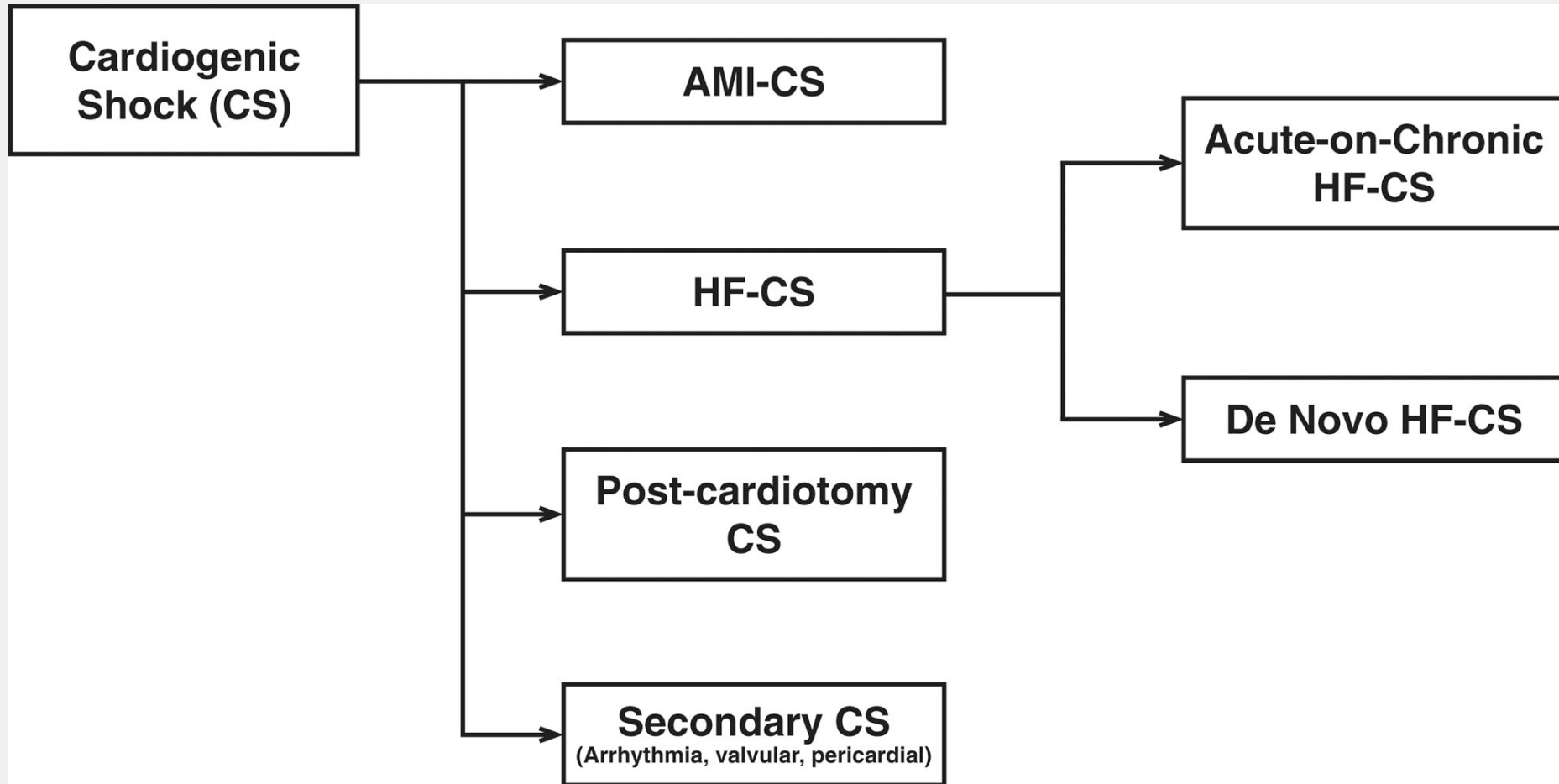


SCAI-CSWG Shock Stages



Kapur NK et al. *J Am Coll Cardiol.* 2022;80(3):185-198

Shock Academic Research Consortium (SHARC) Classification of Cardiogenic Shock



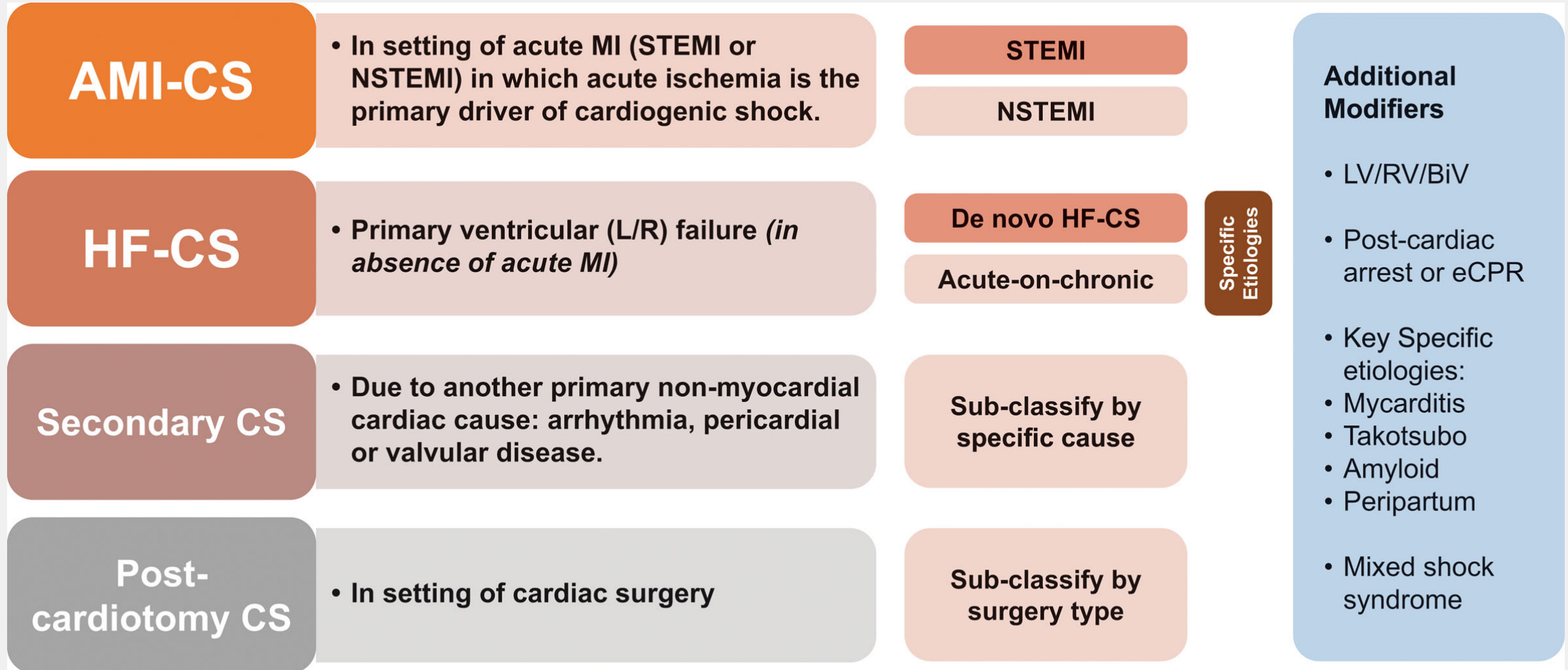
Waksman R et al. *Circulation*. 2023;148(14):1113-1126.



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SHARC Classification of Cardiogenic Shock

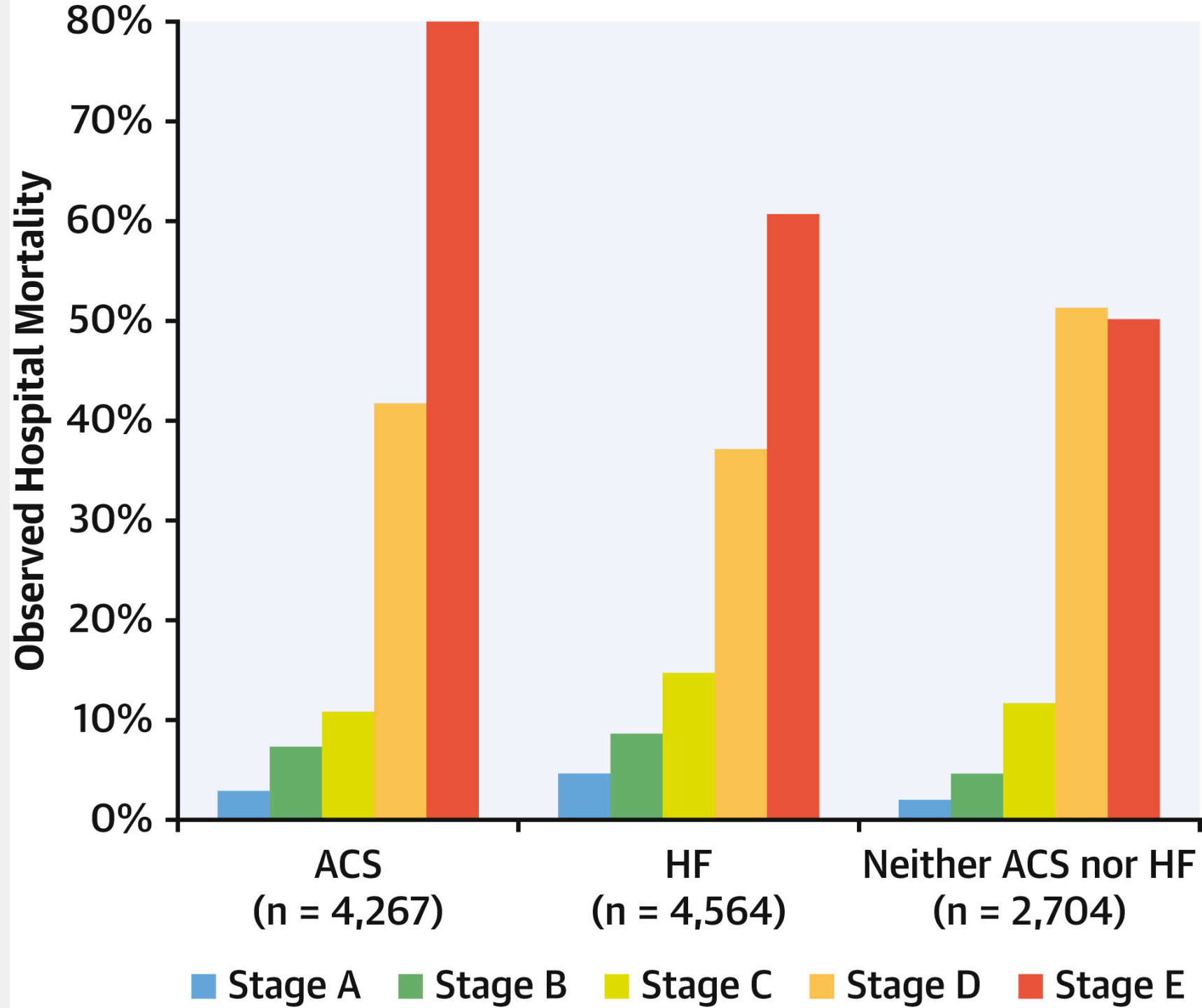


Waksman R et al. *Circulation*. 2023;148(14):1113-1126.

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Hospital Mortality as a Function of SCAI Shock Stage

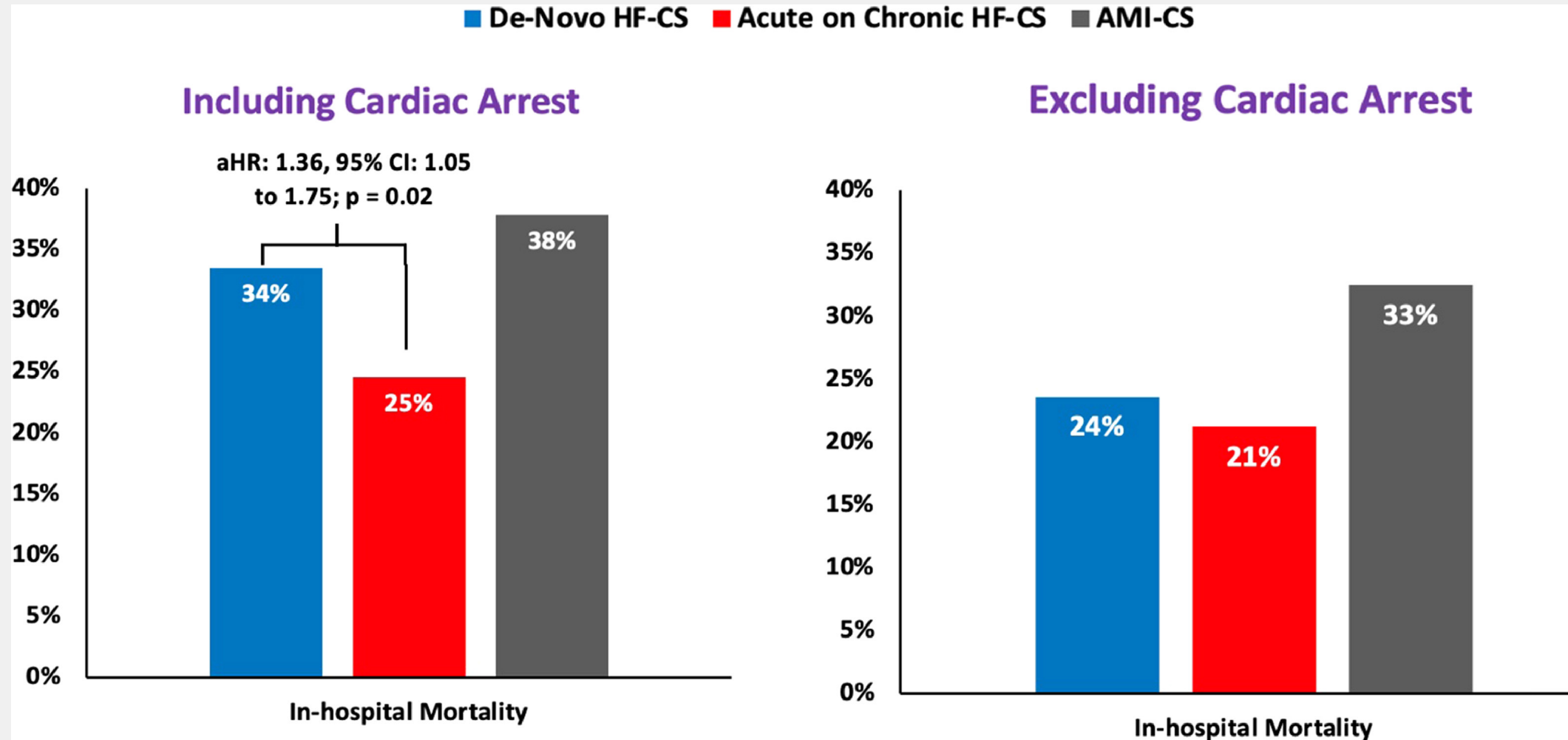


Jentzer, J et al. *JACC*. 2019 Oct, 74 (17) 2117–2128



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De Novo HF-CS vs Acute on Chronic HF-CS



Bhatt AS et al. *J Card Fail.* 2021;27(10):1073-1081



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Interim Summary

Of cardiogenic shock etiologies, **HF-CS now exceeds AMI-CS.**

Staging of shock at frequent intervals is important as cardiogenic shock is dynamic (**B for Bad!!!**)

Congestion is associated with worse outcomes.

Cardiac arrest worsens outcomes in cardiogenic shock.

In-hospital mortality is more in patients with AMI-CS when compared to HF-CS.

Within HF-CS, **De-novo HF-CS has higher mortality** than Acute on Chronic HF-CS.



Pharmacological Therapy for Cardiogenic Shock



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Vasopressors

Which vasopressor do you prefer to use in cardiogenic shock?



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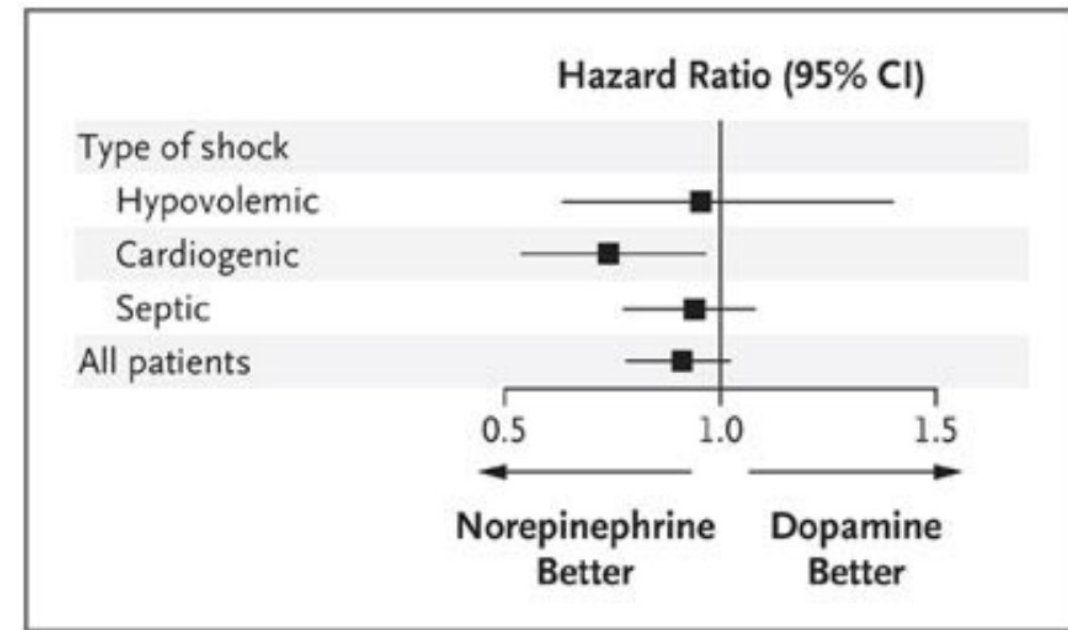
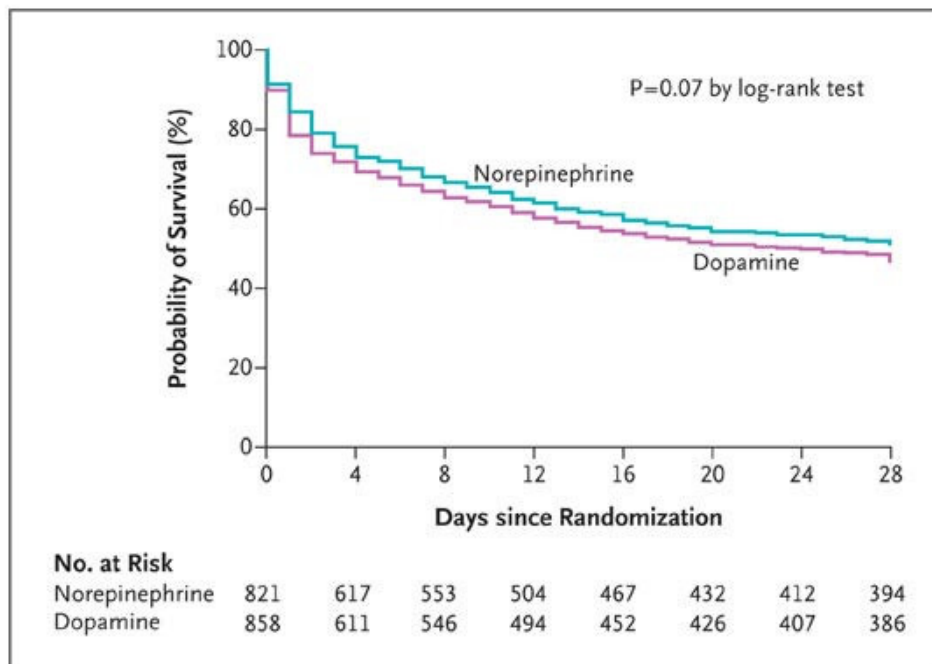
Vasopressors

- The initial goal of therapy in patients with CS and associated hypotension should be focused on the **restoration of perfusion to vital organs, achieved through augmenting MAP and cardiac output.**



Comparison of Dopamine and Norepinephrine in the Treatment of Shock

Authors: Daniel De Backer, M.D., Ph.D., Patrick Biston, M.D., Jacques Devriendt, M.D., Christian Madl, M.D., Didier Chochrad, M.D., Cesar Aldecoa, M.D., Alexandre Brasseur, M.D., Pierre Defrance, M.D., Philippe Gottignies, M.D., and Jean-Louis Vincent, M.D., Ph.D., for the SOAP II Investigators* [Author Info & Affiliations](#)

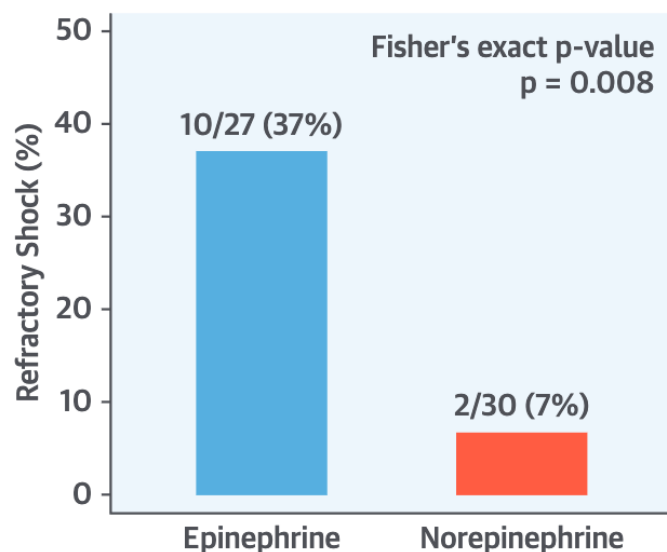


Epinephrine Versus Norepinephrine for Cardiogenic Shock After Acute Myocardial Infarction



N= 57 patients

Bruno Levy, MD, PhD,^a Raphael Clere-Jehl, MD,^b Annick Legras, MD,^c Tristan Morichau-Beauchant, MD,^d Marc Leone, MD, PhD,^e Ganster Frederique, MD,^f Jean-Pierre Quenot, MD, PhD,^g Antoine Kimmoun, MD, PhD,^a Alain Cariou, MD, PhD,^d Johan Lassus, MD, PhD,^h Veli-Pekka Harjola, MD, PhD,^h Ferhat Meziani, MD, PhD,^b Guillaume Louis, MD,ⁱ Patrick Rossignol, MD, PhD,^j Kevin Duarte, PhD,^j Nicolas Girerd, MD, PhD,^j Alexandre Mebazaa, MD, PhD,^k Philippe Vignon, MD, PhD^l

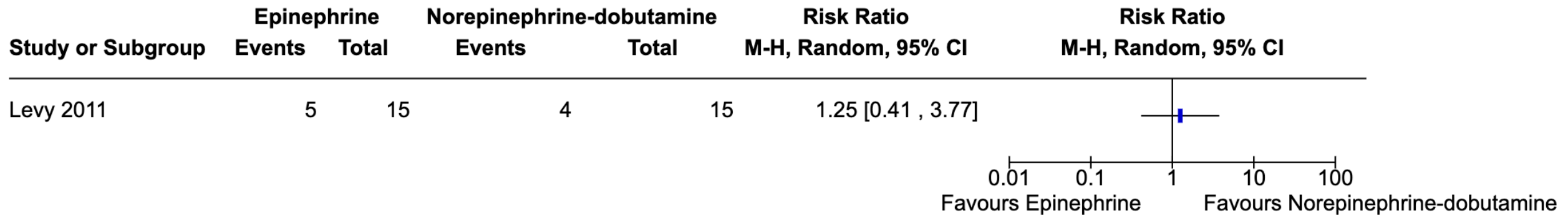


- (1) There were no differences observed in MAP, cardiac index, or stroke volume in patients treated with either epinephrine or norepinephrine
- (2) Epinephrine treatment was associated with worse metabolic acidosis and increased lactate levels
- (3) Those treated with Epi experienced significantly greater increases in heart rate and a concomitant increase in the cardiac double product, an indirect surrogate of myocardial oxygen consumption
- (4) The study was terminated prematurely due to increased rates of refractory CS (odds ratio [OR], 8.24 [95% CI, 1.61–42.18], $P=0.01$) developing in the epinephrine-treated arm.



Cochrane analysis

- 19 eligible studies including 2385 individuals
- Insufficient evidence to support the superiority of a particular inotrope or vasodilating agent in cardiogenic shock, especially with respect to a mortality benefit.



Uhlig K et al. Cochrane Database of Systematic Reviews 2020, Issue 11. Art. No.: CD009669.



Current guidelines of vasopressor therapy

Indication to commence therapy	Hypotension (systolic blood pressure <90 mm Hg) and/or evidence of end-organ hypoperfusion				
Societal guideline	ESC HF	ACC/AHA HF	ESC STEMI	AHA CS	AHA AMI-CS
Recommendation and level of evidence	IIb - B/C	IIa - B	IIb - C	N/A	N/A
First-line agent	Hypotensive: Norepinephrine Low output: No recommendation	Hypotensive: Clinician preference Low output: Clinician preference	Hypotensive: Norepinephrine Low output: Dobutamine	Hypotensive: Norepinephrine or Dopamine Low output: Norepinephrine or Dopamine	Hypotension: Norepinephrine

Bloom JE et al. *J Am Heart Assoc.* 2023;12(15):e029787.

Inotropes

ORIGINAL ARTICLE

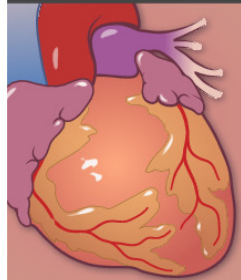


Milrinone as Compared with Dobutamine in the

The NEW ENGLAND JOURNAL of MEDICINE

Milrinone vs. Dobutamine in Cardiogenic Shock

DOUBLE-BLIND, RANDOMIZED TRIAL



192

Patients admitted to the cardiac ICU with cardiogenic shock

Milrinone

N=96



Dobutamine

N=96



In-hospital death from any cause, TIA, stroke, or cardiovascular or renal events

49%

47 patients

54%

52 patients

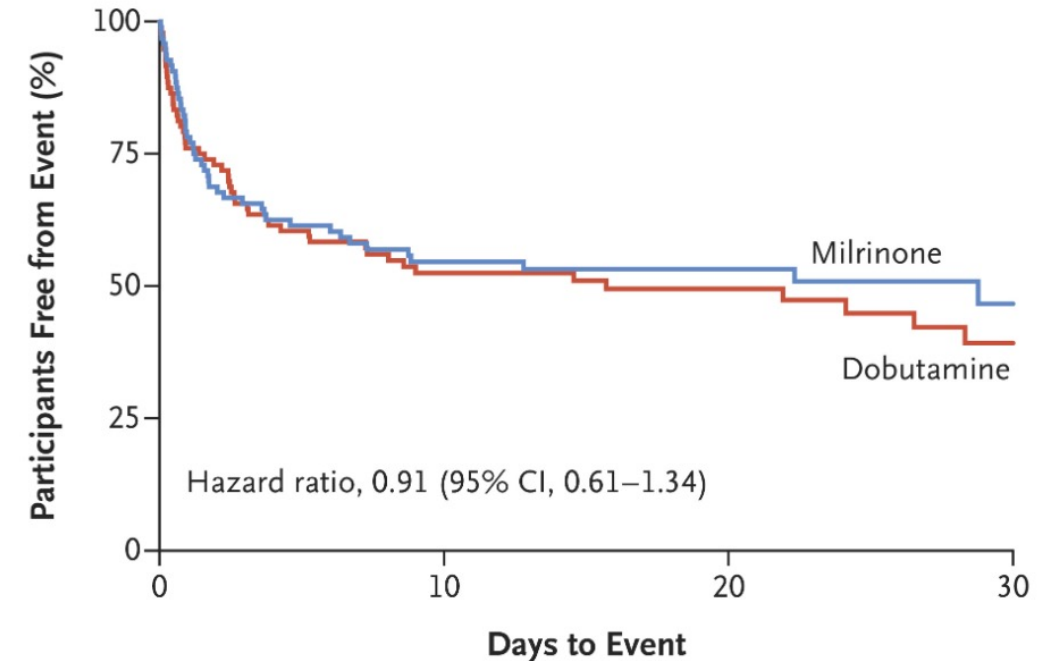
Relative risk, 0.90; 95% CI, 0.69–1.19; P=0.47

No between-group difference was observed in the primary composite outcome or in important secondary outcomes.

R. Mathew et al. 10.1056/NEJMoa2026845

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A Primary Composite Outcome



No. at Risk

Milrinone	96	42	26	7
Dobutamine	96	43	25	13



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Inotropes: Signal towards harm?

Original Contribution

FREE

Short-term Intravenous Milrinone for Acute Exacerbation of Chronic Heart Failure

A Randomized Controlled Trial

Michael S. Cuffe, MD; Robert M. Califf, MD; Kirkwood F. Adams, Jr, MD ; et al

- Increased in-hospital mortality
- Increased atrial arrhythmias
- Increased hypotension



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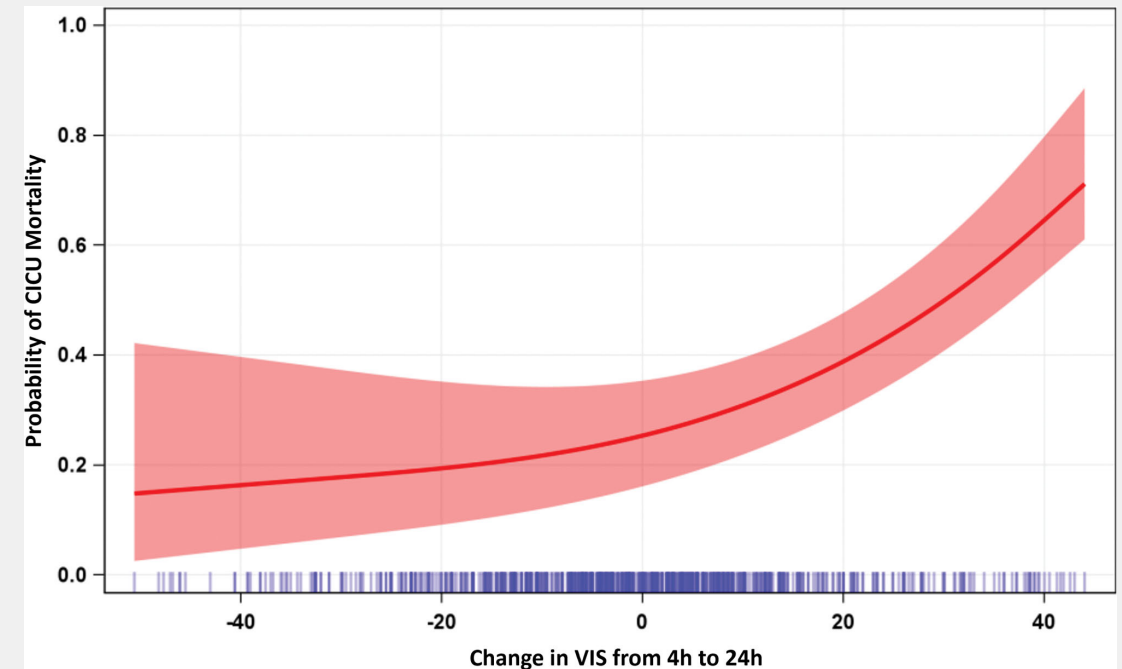
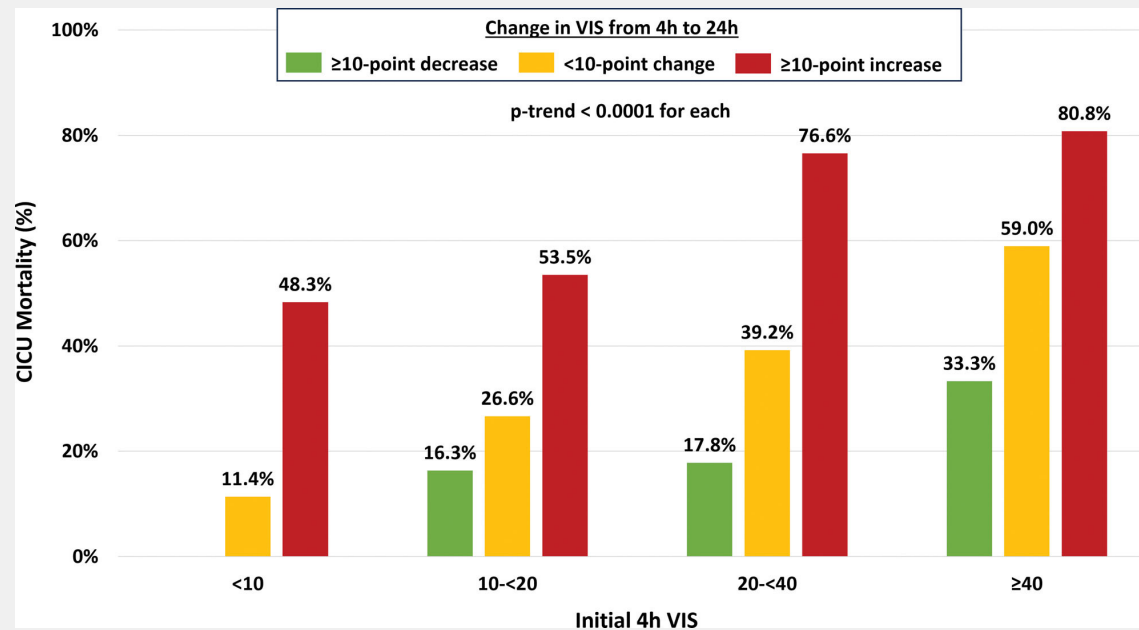
Early Serial Assessment of Aggregate Vasoactive Support and Mortality in Cardiogenic Shock: Insights From the Critical Care Cardiology Trials Network Registry

Siddharth M. Patel, MD, MPH , David D. Berg, MD, MPH , Erin A. Bohula, MD, DPhil , Vivian M. Baird-Zars, MPH, Gregory W. Barsness, MD , Sunit-Preet Chaudhry, MD , Meshe D. Chonde, MD , ... [SHOW ALL](#) ... , and David A. Morrow, MD, MPH  | [AUTHOR INFO & AFFILIATIONS](#)

[AFFILIATIONS](#)

Circulation: Heart Failure • Volume 17, Number 5 • <https://doi.org/10.1161/CIRCHEARTFAILURE.124.011736>

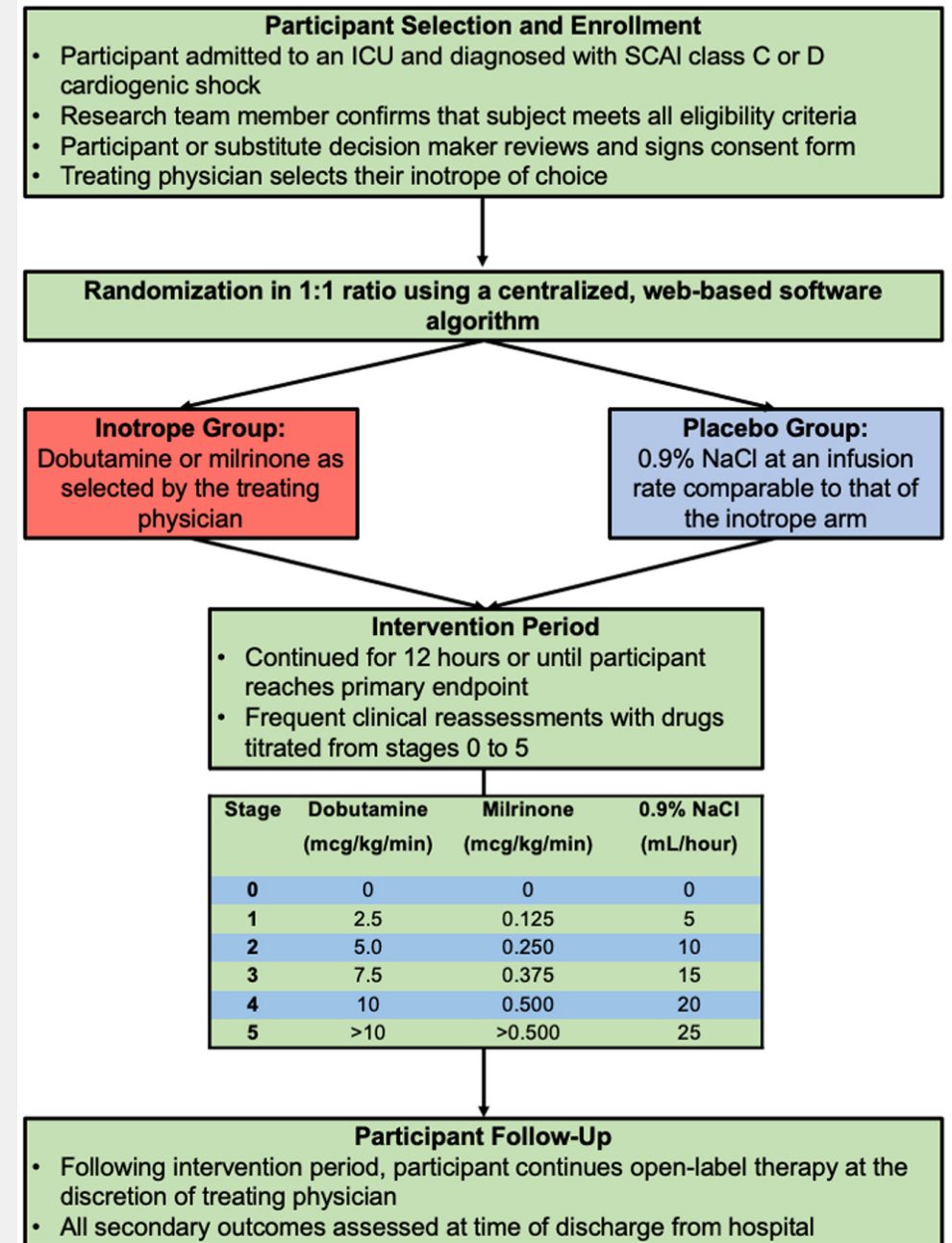
Vasoactive-inotropic score (VIS) =
dobutamine + dopamine + 10 ×
phenylephrine + 10 × milrinone + 100 ×
epinephrine + 100 × norepinephrine +
10 000 × vasopressin



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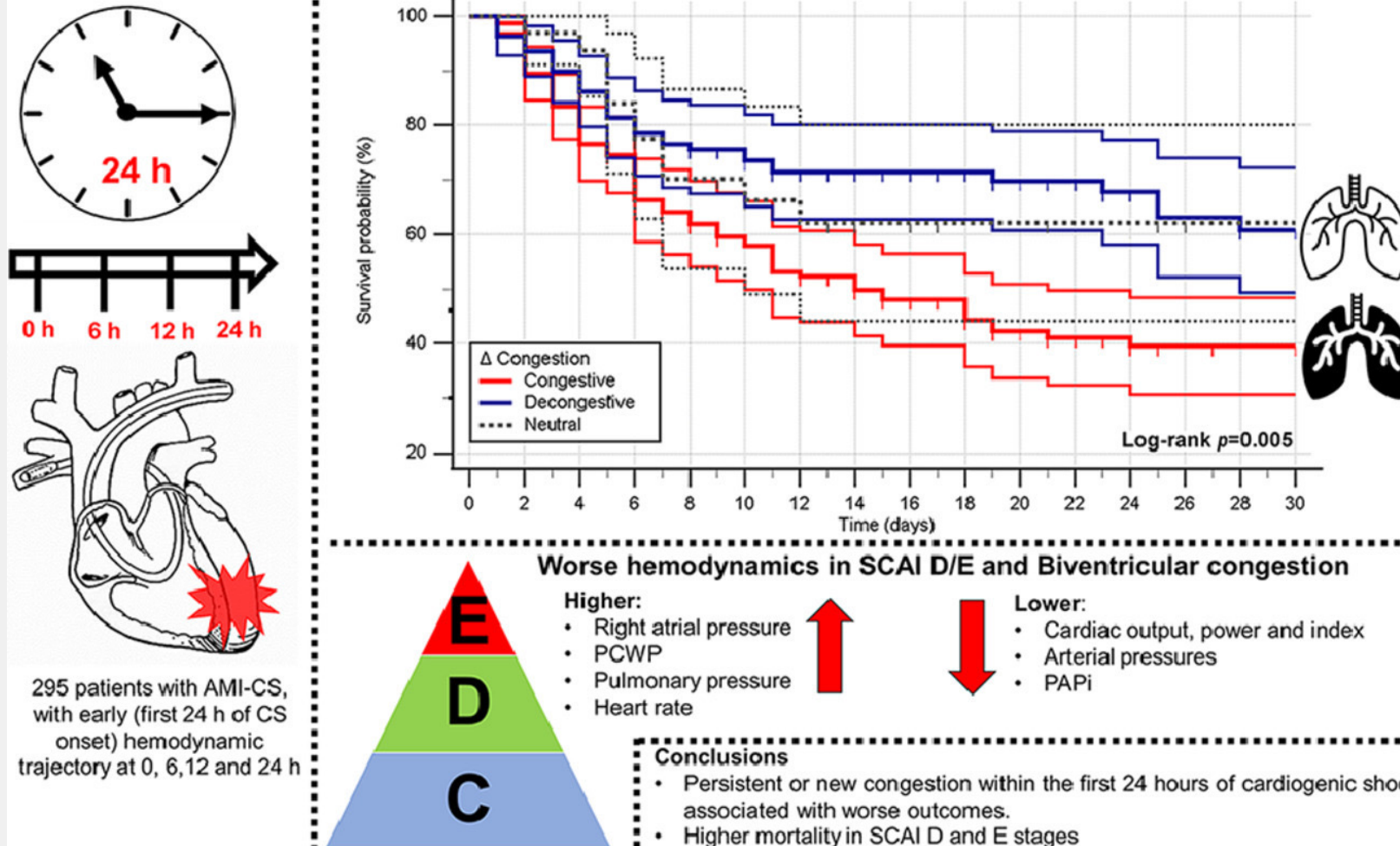
CAPITAL DOREMI II TRIAL



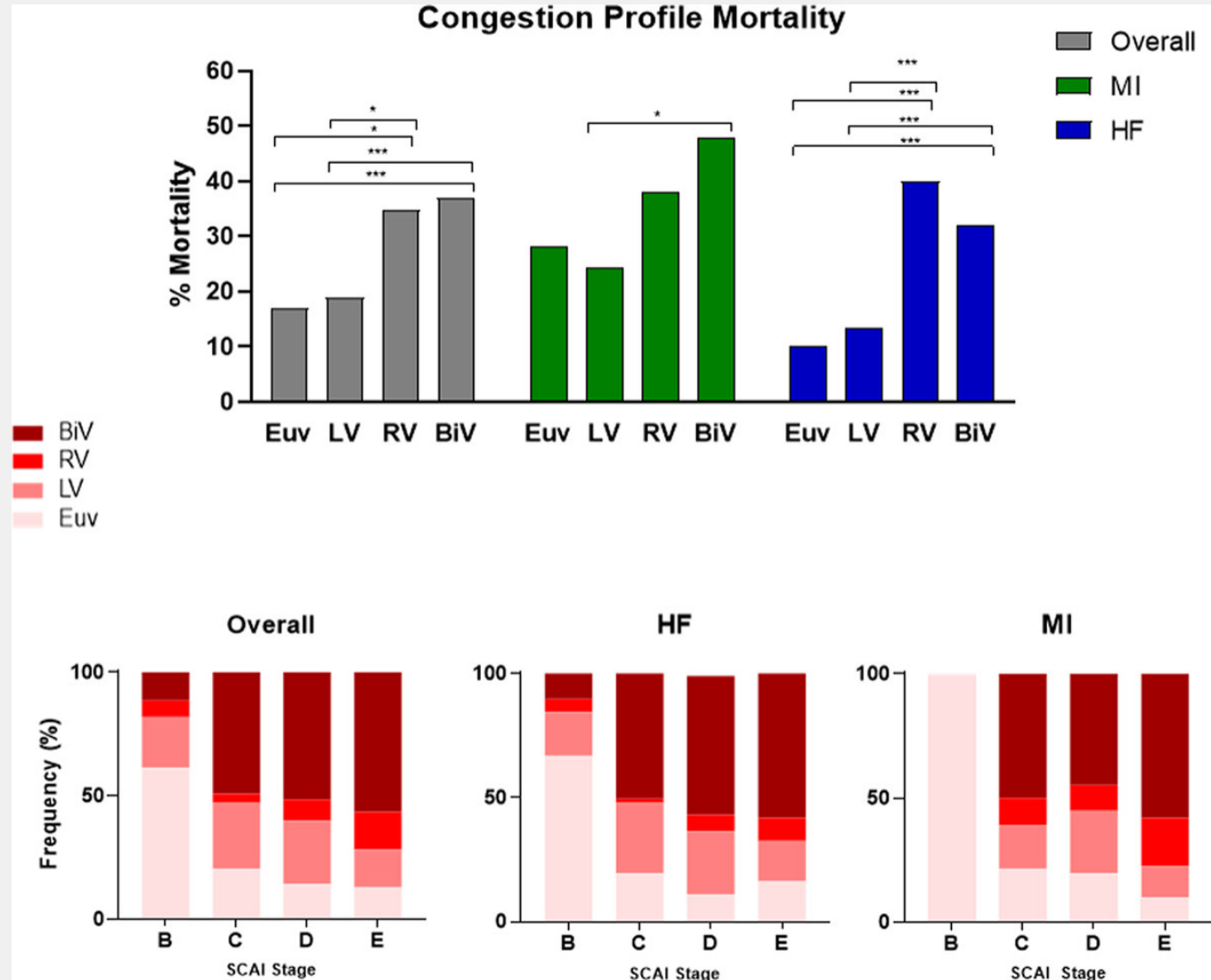
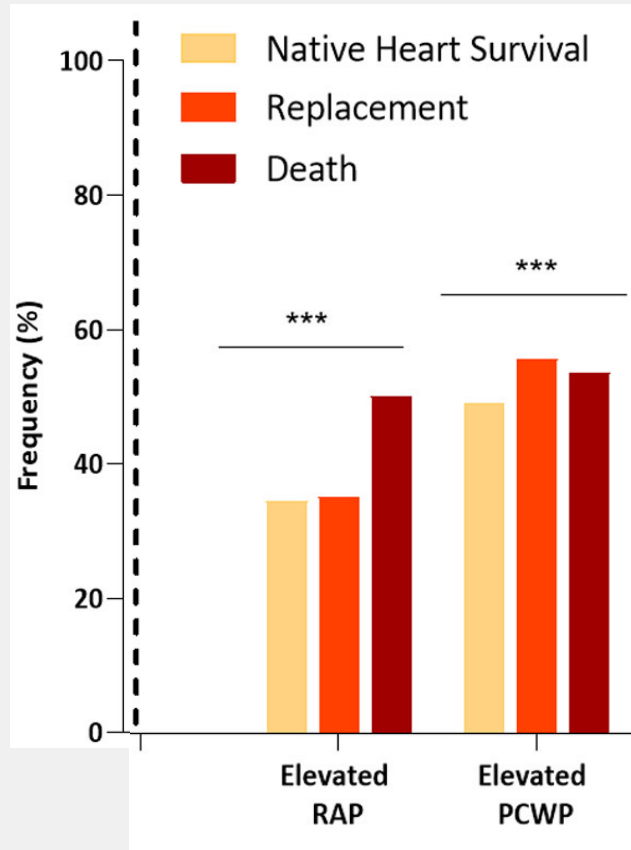
Congestion matters!

Dynamic Invasive Hemodynamic Congestion Profile Impacts Acute Myocardial Infarction

Complicated by Cardiogenic Shock Outcomes: A Real-World Single-Center Study



Congestion matters!

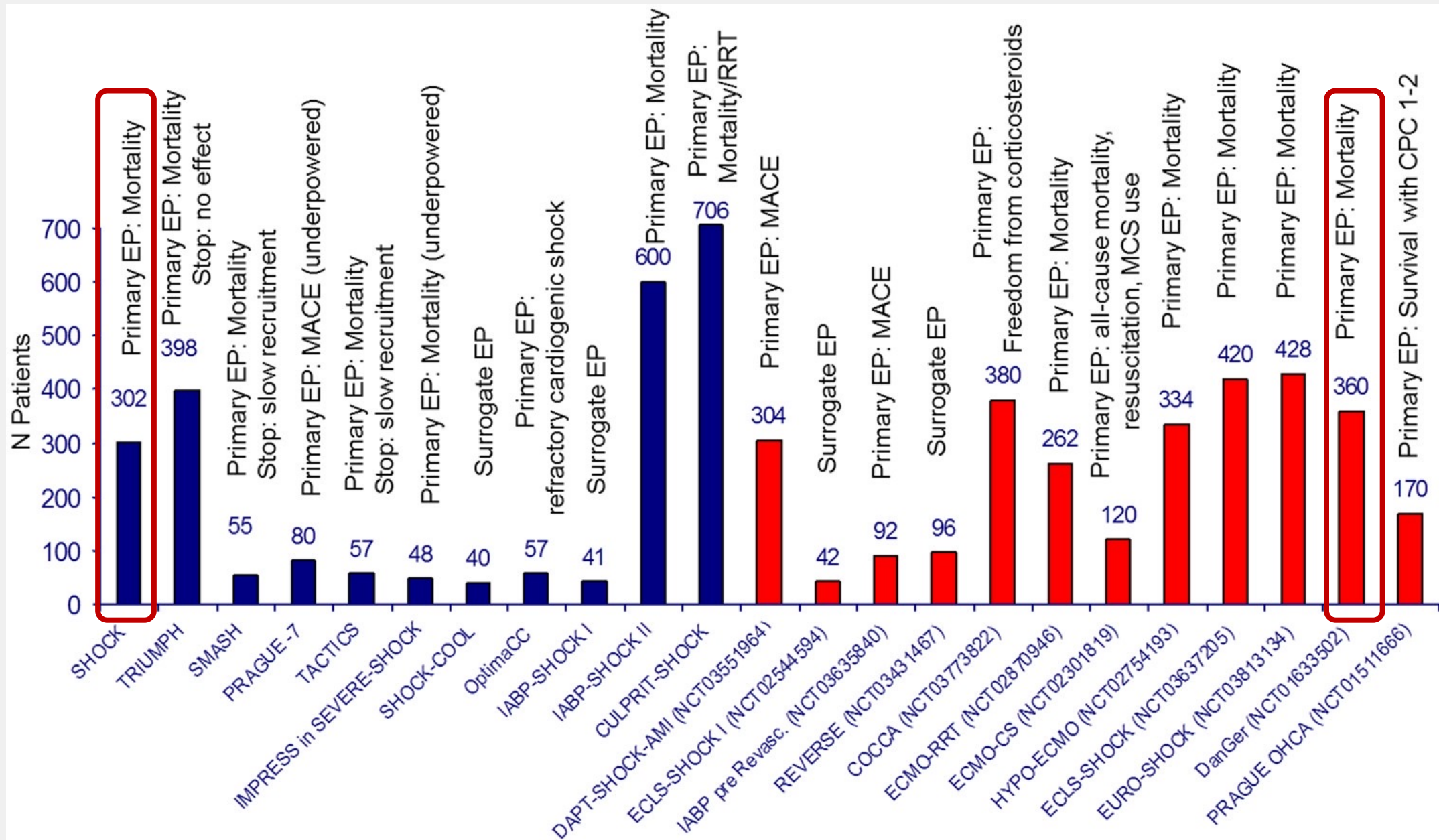


Invasive Therapies for Cardiogenic Shock



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Holger Thiele et al. *European Heart Journal*, August 2019

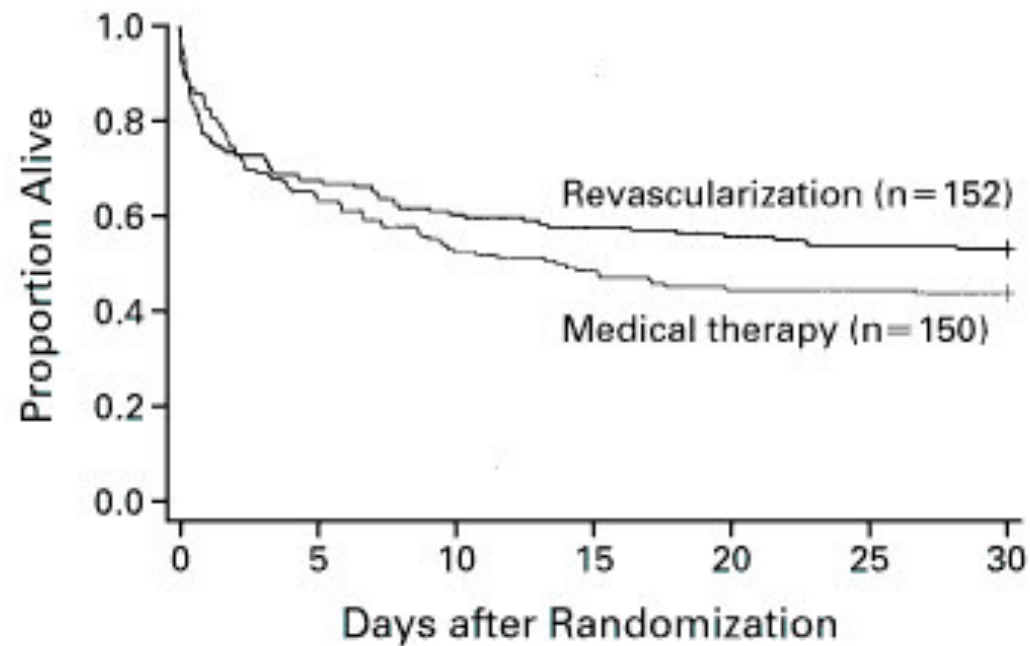
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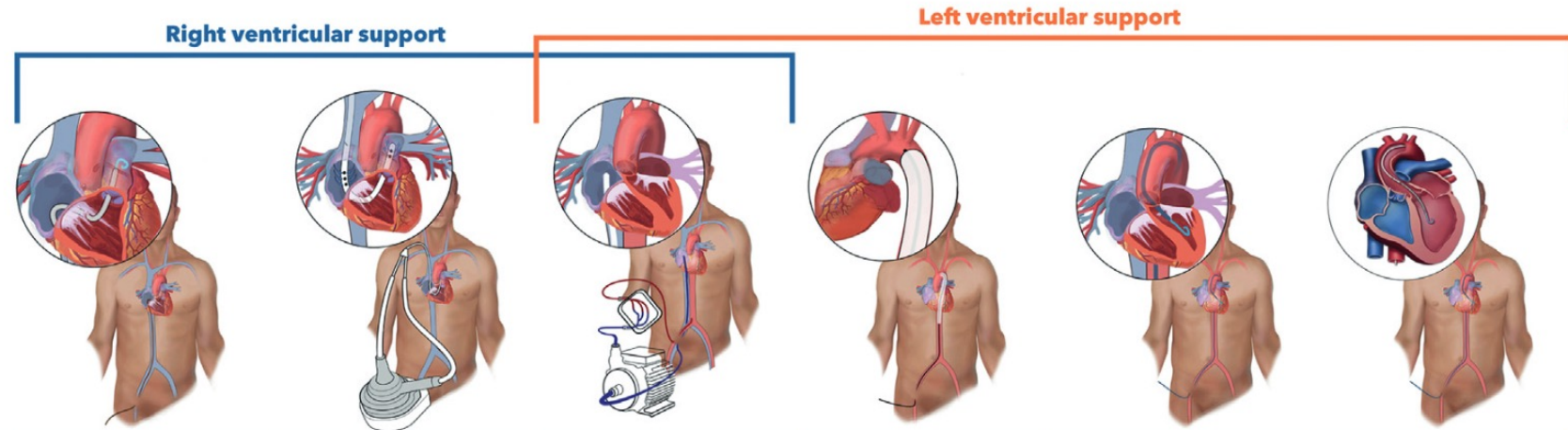
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Early Revascularization in Acute Myocardial Infarction Complicated by Cardiogenic Shock

Authors: Judith S. Hochman, M.D., Lynn A. Sleeper, Sc.D., John G. Webb, M.D., Timothy A. Sanborn, M.D., Harvey D. White, D.Sc., J. David Talley, M.D., Christopher E. Buller, M.D., [+16](#), for the SHOCK Investigators* [Author Info & Affiliations](#)



MCS Armamentarium

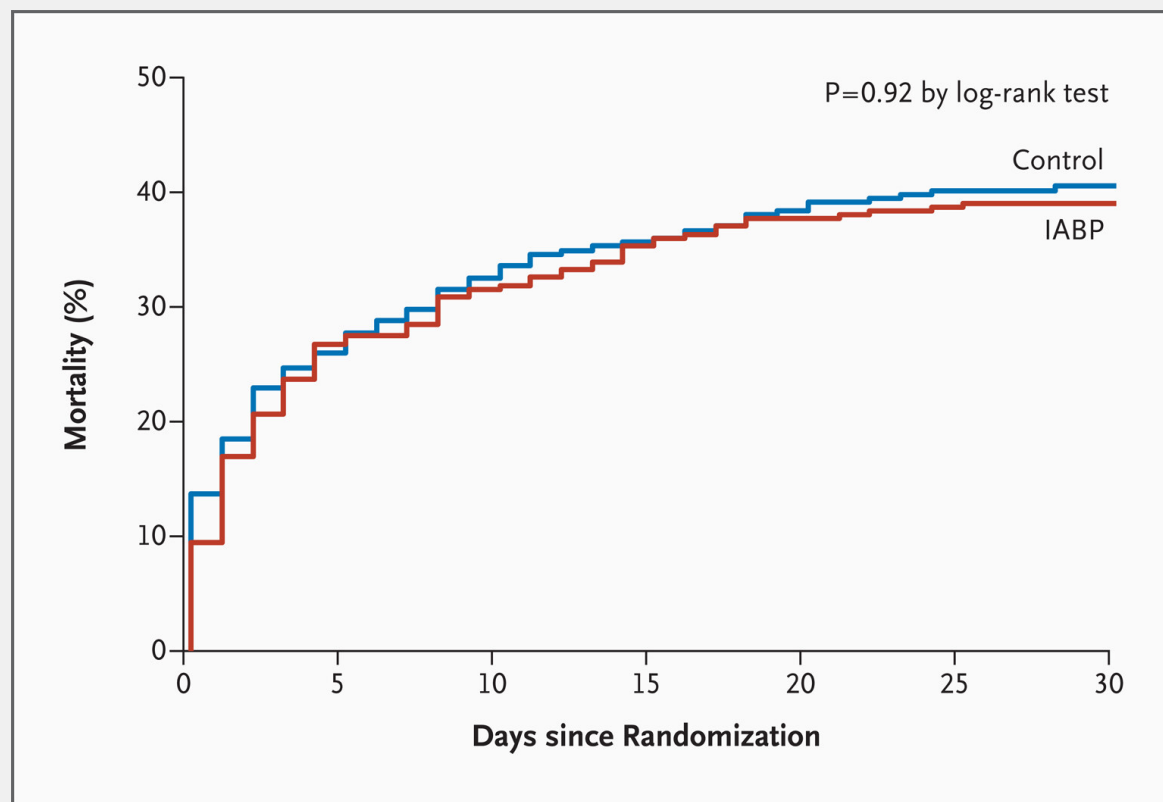


	Impella RP Flex	RA-PA pVAD	VA-ECMO	IABP	Impella CP	Impella 5.5
Max flow	3.0 - 4.0 L/min	4.0 - 5.0 L/min	5.0 - 7.0 L/min	0.5 - 1.0 L/min	3.0 - 4.3 L/min	5.0 - 6.0 L/min
Max pump speed	33,000 rpm	7,500 rpm	6,000 rpm	NA	46,000 rpm	33,000 rpm
Mechanism	Axial flow continuous pump (RA-to-PA)	Centrifugal flow continuous pump (RA-to-PA)	Centrifugal flow continuous pump (RA-to-AO)	Balloon inflation-deflation (AO)	Axial flow continuous pump (LV-to-AO)	Axial flow continuous pump (LV-to-AO)
Sheath size	23 F venous peel-away	29 or 31 F venous (inflow)	15-24 F arterial 19-25 F venous	7-8 F arterial	14 F arterial peel-away	23 F arterial peel-away
Typical insertion/ placement	Internal jugular vein	Internal jugular vein	Femoral vein (drain) Femoral artery (return)	Femoral artery or Axillary artery	Femoral artery or Axillary artery	Axillary artery
Direct LV unloading	-	-	-	-	+++	+++
Direct RV unloading	+	+	+	-	-	-
Afterload	-	-	↑↑↑	↓↓	↓	↓
Coronary perfusion	-	-	↑↑	↑↑	↑↑	↑↑



Intraaortic Balloon Support for Myocardial Infarction with Cardiogenic Shock

Authors: Holger Thiele, M.D., Uwe Zeymer, M.D., Franz-Josef Neumann, M.D., Miroslaw Ferenc, M.D., Hans-Georg Olbrich, M.D., Jörg Hausleiter, M.D., Gert Richardt, M.D., ⁺¹², for the IABP-SHOCK II Trial Investigators* [Author Info](#) & [Affiliations](#)



Baseline Variable	No. of Patients	IABP 30-day mortality (%)	Control 30-day mortality (%)	Relative Risk (95% CI)	P Value for Interaction
Sex					0.61
Female	187	44.4	43.2	1.03 (0.74–1.43)	
Male	411	37.3	40.5	0.92 (0.72–1.18)	
Age					0.09
<50 yr	70	19.4	44.1	0.44 (0.21–0.95)	
50–75 yr	334	34.6	36.5	0.95 (0.71–1.27)	
>75 yr	194	53.7	50.0	1.07 (0.81–1.41)	
Diabetes					0.82
Yes	195	42.9	46.7	0.92 (0.67–1.26)	
No	399	37.2	38.9	0.96 (0.74–1.23)	
Hypertension					0.05
Yes	410	42.9	40.4	1.06 (0.84–1.34)	
No	183	28.9	43.0	0.67 (0.45–1.01)	
Type of MI					0.76
STEMI/LBBB	412	41.0	42.9	0.96 (0.77–1.21)	
Non-STEMI	177	37.5	38.3	0.98 (0.67–1.43)	
STEMI type					0.14
Anterior	216	35.4	43.7	0.81 (0.58–1.13)	
Nonanterior	196	48.3	42.2	1.16 (0.85–1.57)	
Previous infarction					0.04
Yes	131	47.9	33.3	1.44 (0.93–2.21)	
No	466	37.3	43.3	0.86 (0.69–1.07)	
Hypothermia					0.31
Yes	226	48.1	44.2	1.09 (0.82–1.44)	
No	372	35.1	39.3	0.89 (0.68–1.16)	
Blood pressure					0.76
<80 mm Hg	161	50.7	46.4	1.09 (0.79–1.50)	
≥80 mm Hg	432	35.9	39.2	0.92 (0.72–1.17)	

0.0 0.5 1.0 1.5 2.0 2.5

IABP Better Control Better

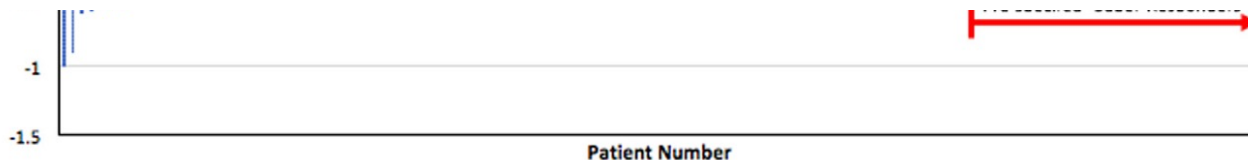


IABP in HF-CS

CHANGE IN CARDIAC OUTPUT FOLLOWING IABP INSERTION

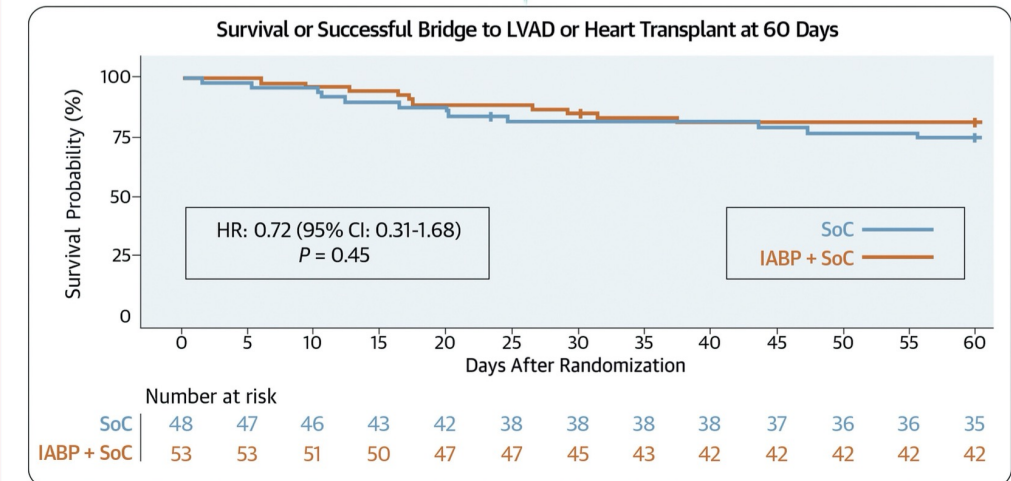
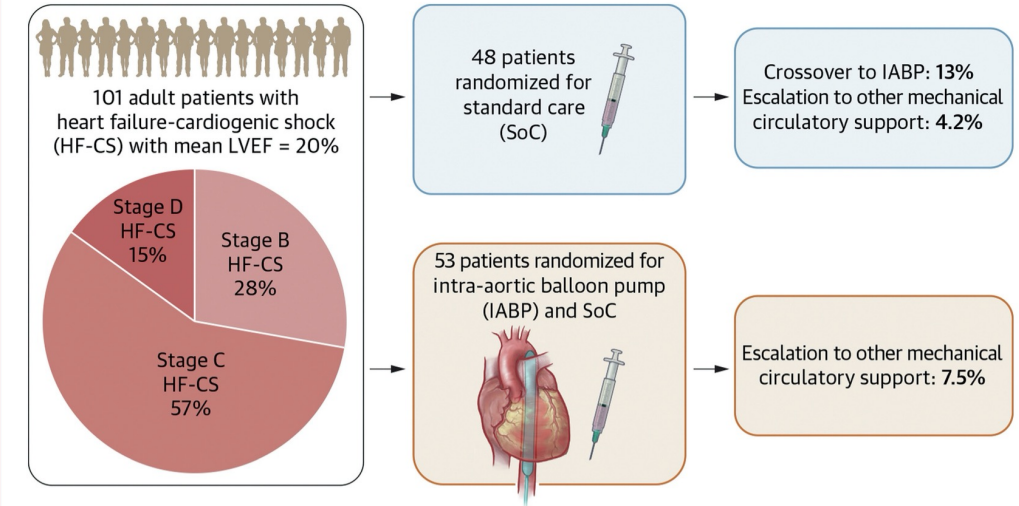
TABLE 3. Multivariable predictors of hemodynamic response to intra-aortic balloon pump

Variable	Odds Ratio
Heart rate >90 bpm	1.52
Systemic vascular resistance >1300 dynes/sec/cm ⁻⁵	5.04
Pulse pressure >30 mm Hg	1.07
Right atrium to pulmonary artery diastolic pressure <0.60	1.30
Moderate to severe mitral regurgitation	2.42



Fried JA et al. *J Heart Lung Transplant*. 2018;37(11):1313-1321.

CENTRAL ILLUSTRATION: Early Intra-Aortic Balloon Pump in Heart Failure Complicated by Cardiogenic Shock



The routine early use of IABP plus standard care, compared to standard care alone, did not result in significantly better survival or successful bridge to LVAD or heart transplantation in patients with HF-CS.

Morici N, et al. *JACC*. 2025;85(16):1587-1597.

Morici, N et al. *JACC*. 2025 Apr, 85 (16) 1587–1597.

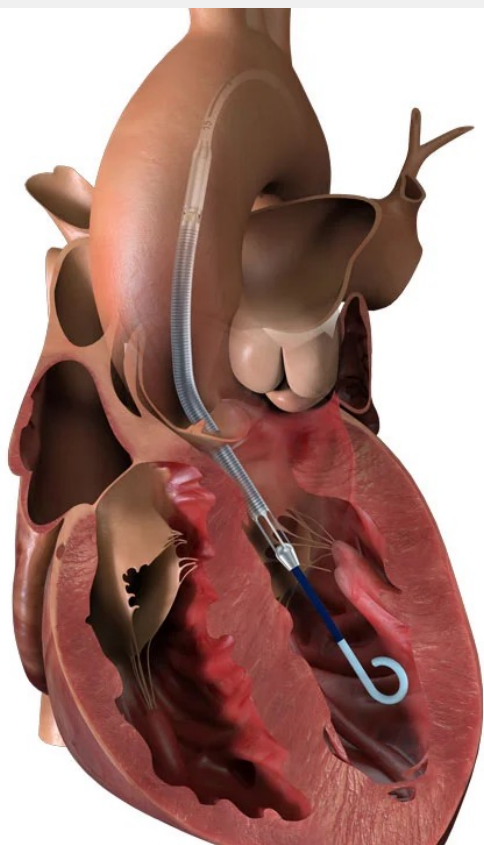
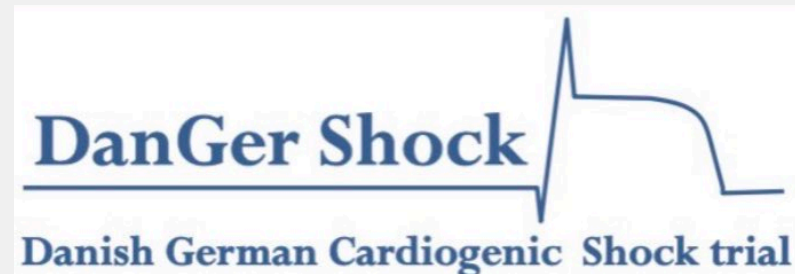
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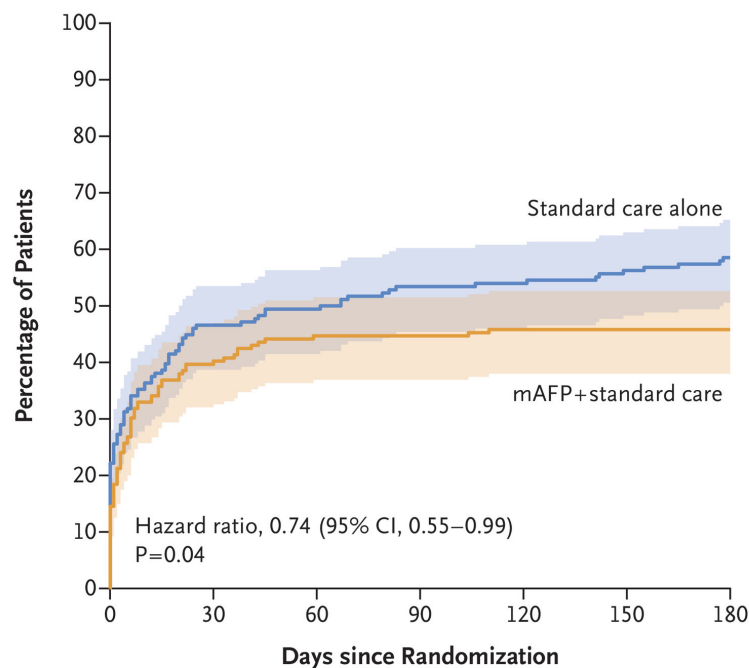
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Microaxial Flow Pump or Standard Care in Infarct-Related Cardiogenic Shock

Authors: Jacob E. Møller, D.M.Sc. , Thomas Engstrøm, D.M.Sc., Lisette O. Jensen, D.M.Sc., Hans Eiskjær, D.M.Sc., Norman Mangner, M.D. , Amin Polzin, M.D., P. Christian Schulze, M.D.,  +29, for the DanGer Shock Investigators* [Author Info & Affiliations](#)



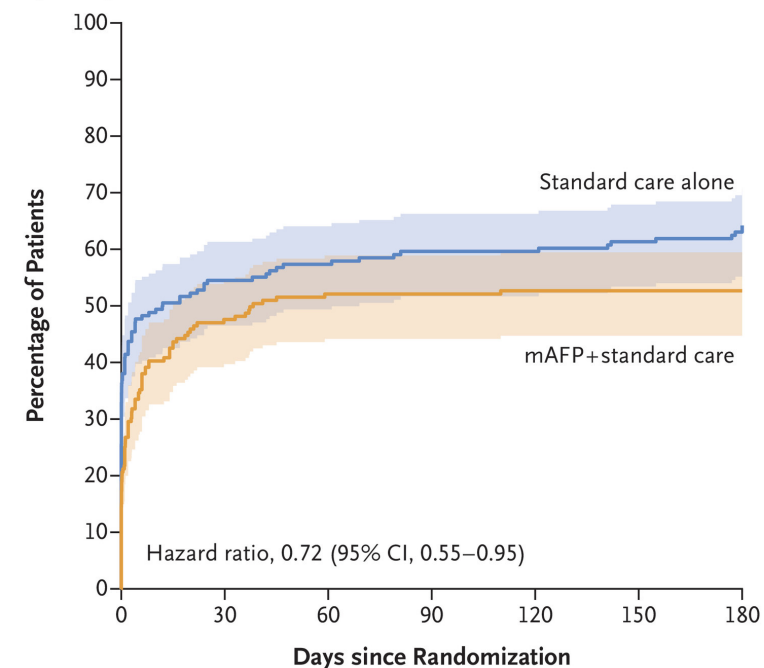
A Death from Any Cause



No. at Risk

Standard care	176	94	89	82	81	77	72
mAFP+standard care	179	108	99	99	97	97	97

B Secondary Composite Cardiac End-Point Event



No. at Risk

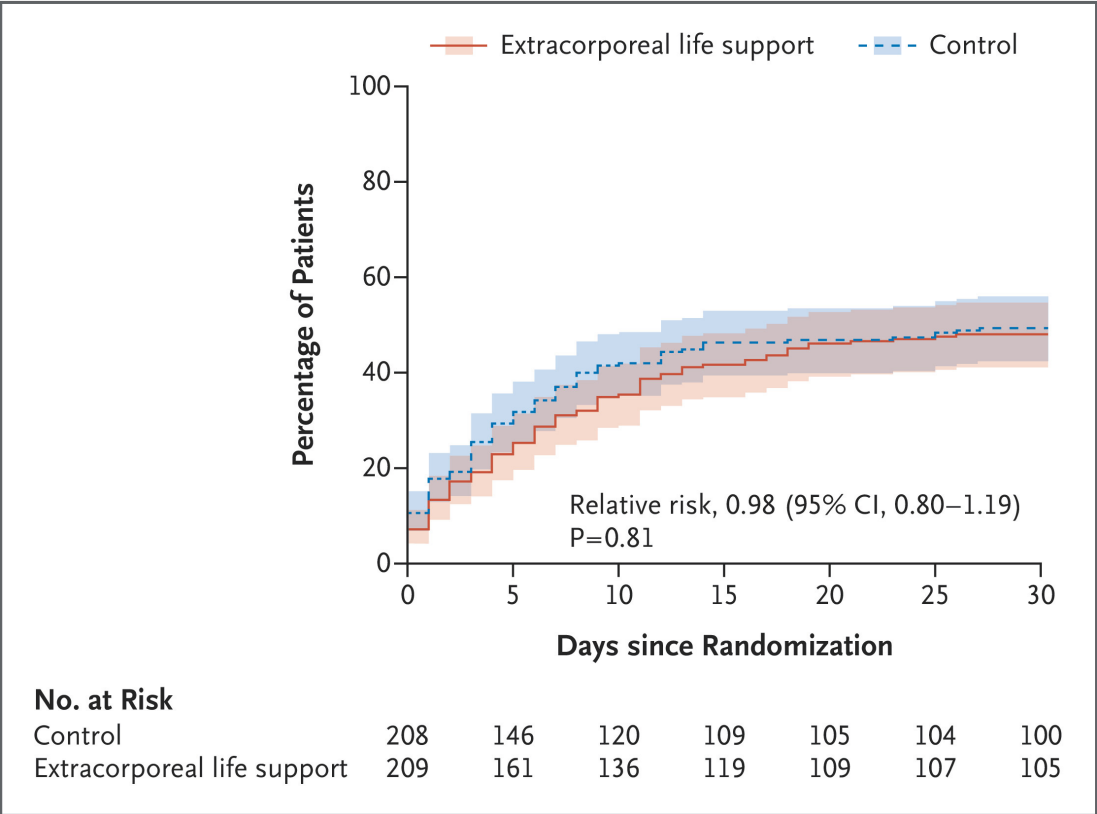
Standard care	176	80	75	71	71	68	64
mAFP+standard care	179	93	85	85	84	84	84



Extracorporeal Life Support in Infarct-Related Cardiogenic Shock

Authors: Holger Thiele, M.D. , Uwe Zeymer, M.D., Ibrahim Akin, M.D., Michael Behnes, M.D., Tienush Rassaf, M.D., Amir Abbas Mahabadi, M.D., Ralf Lehmann, M.D.,  +28, for the ECLS-SHOCK Investigators* [Author Info &](#)

[Affiliations](#)



**Objective:** to evaluate extracorporeal life support (ECLS) compared with control among patients with acute myocardial infarction (MI) and cardiogenic shock.

420 patients

Inclusion criteria: Acute MI and cardiogenic shock
Planned revascularization; SBP <90 mm Hg or vasoactive drugs to support BP with 1) altered mental status, 2) cold/clammy skin, or 3) urine output <30 cc/h, Lactate >3

 **ECLS**
(n = 211)

VS.

 **usual care**
(n = 209)

PRIMARY OUTCOME

47.8

30-day mortality %
RR, 0.98; 95% CI, 0.80 to 1.19; P=0.81

49

SECONDARY OUTCOMES

23.4

Moderate or severe bleeding %
RR, 2.44; 95% CI, 1.50 to 3.95

9.6

11

Vascular complication requiring surgery or intervention %
relative risk, 2.86; 95% CI, 1.31 to 6.25

3.8

Conclusion: In patients with acute myocardial infarction complicated by cardiogenic shock with planned early revascularization, the risk of death from any cause at the 30-day follow-up was not lower among the patients who received ECLS therapy than among those who received medical therapy alone.



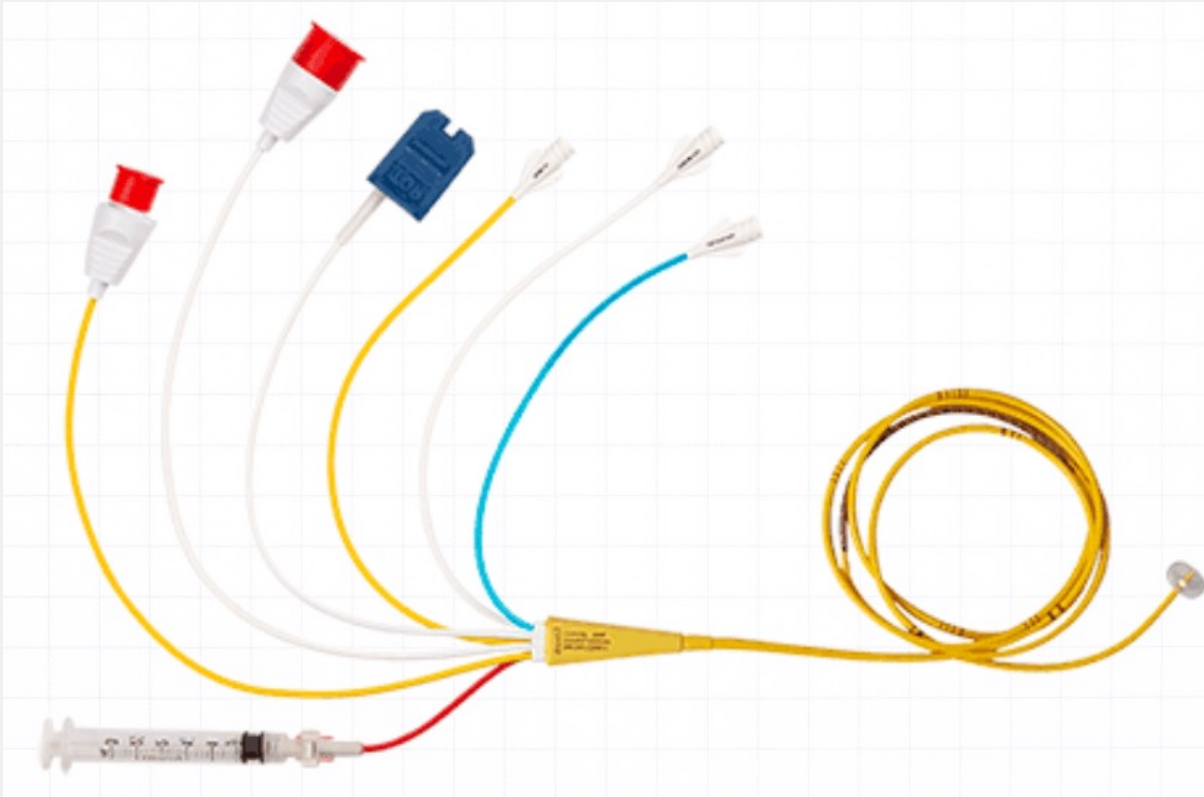
Utility of the Swan-Ganz Catheter



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Swan-Ganz Catheter



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Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness

The ESCAPE Trial

The ESCAPE Investigators and ESCAPE Study Coordinators*

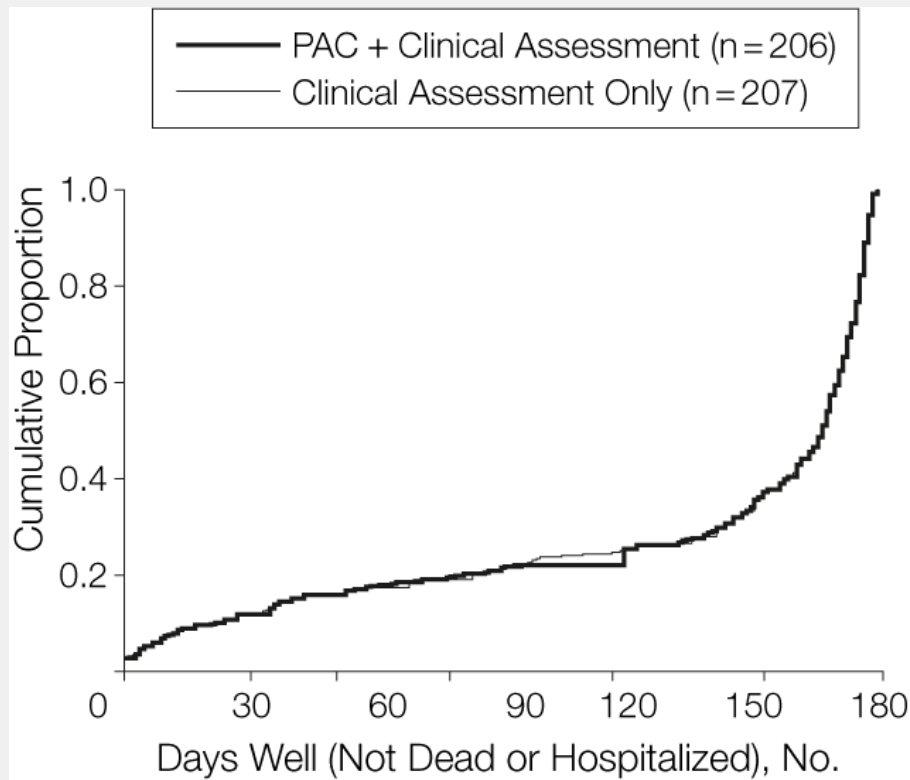


Table 4. Primary Outcomes: Mortality and Hospitalizations

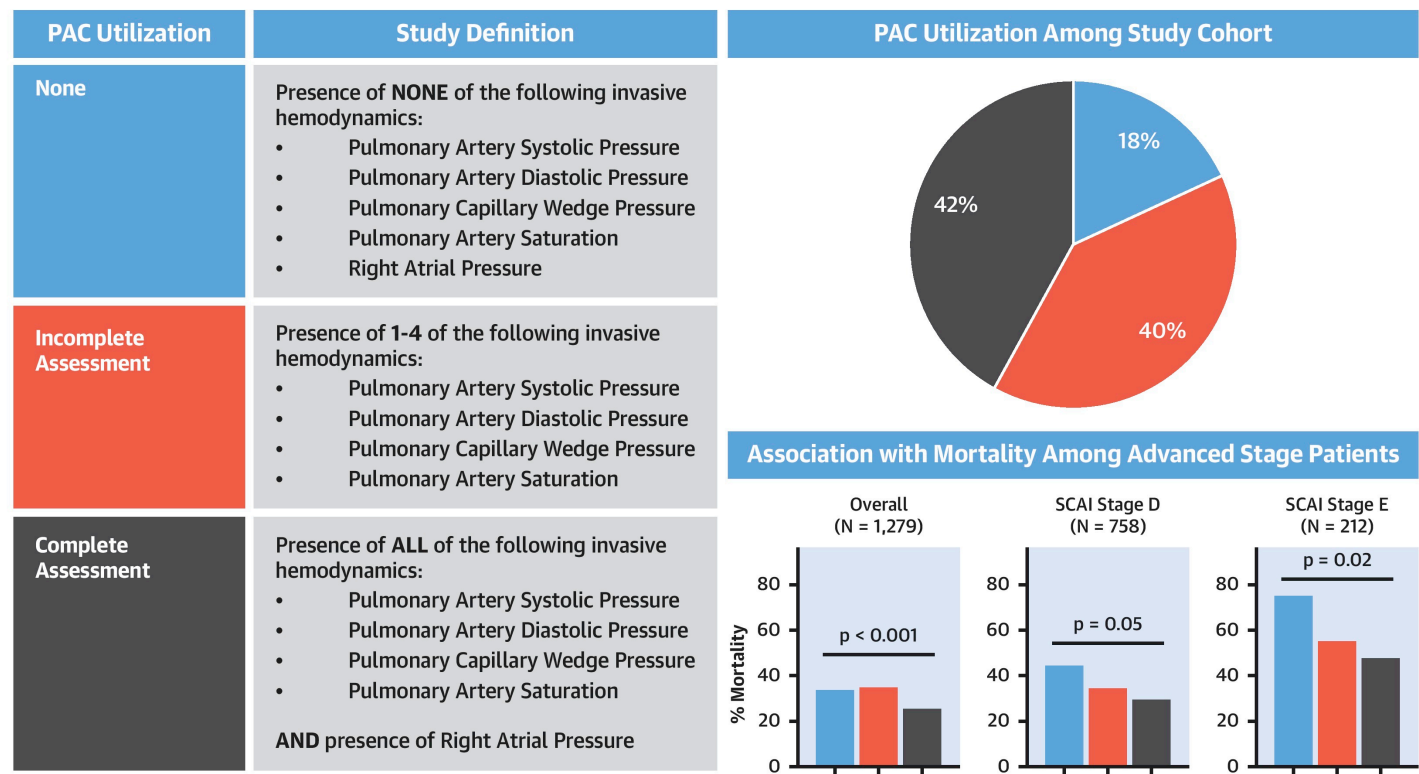
Measure	PAC Group	Clinical Assessment Group	End Point Estimate (95% CI)*	χ^2	P Value
Days alive out of hospital, mean					
LVADs/transplants coded dead	133	135	Hazard ratio, 1.00 (0.82-1.21)	0.00	.99
LVADs/transplants coded well	141	143	Hazard ratio, 0.99 (0.82-1.21)	0.00	.95
Mortality (dead at 180 d), No.	43	38	Odds ratio, 1.26 (0.78-2.03)	0.86	.35
Total days initial hospitalization, mean	8.7	8.3	Hazard ratio, 1.04 (0.86-1.27)	0.18	.67
PAC-related deaths, No.	0	0	NA	NA	NA
Early deaths (in-hospital plus 30 d), No.	10	11	Odds ratio, 0.97 (0.38-2.22)	0.04	.97

Abbreviations: CI, confidence interval; LVAD, left ventricular assist device; NA, not applicable; PAC, pulmonary artery catheter.

*Values less than 1 favor PAC.

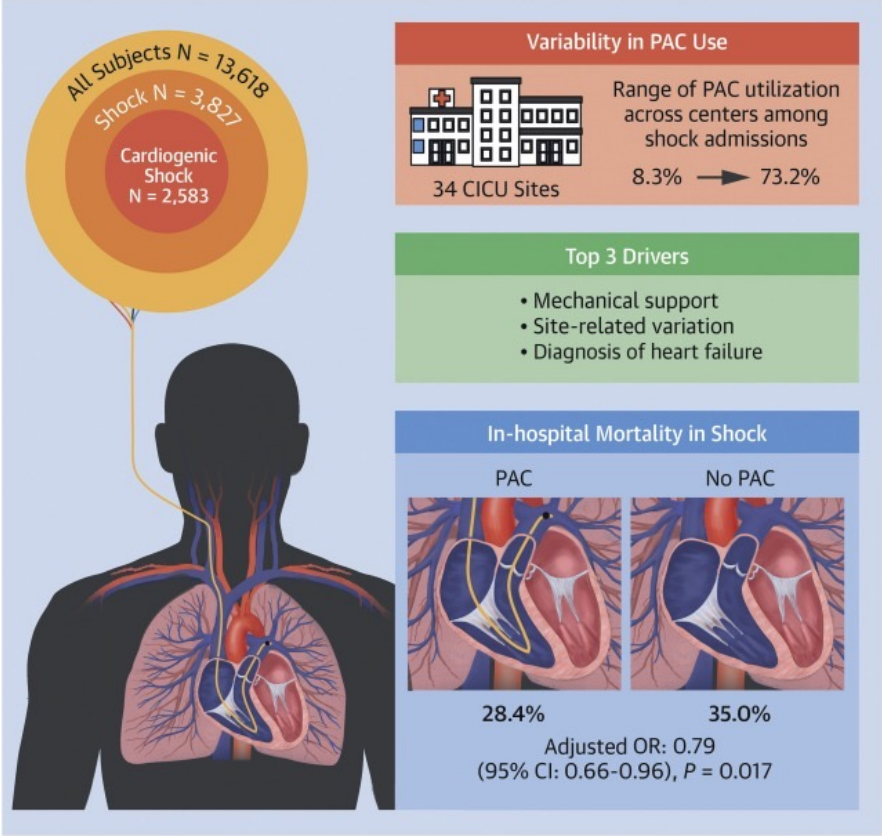


CENTRAL ILLUSTRATION: Frequency of Mortality Among PAC Use Overall and by SCAI Stage



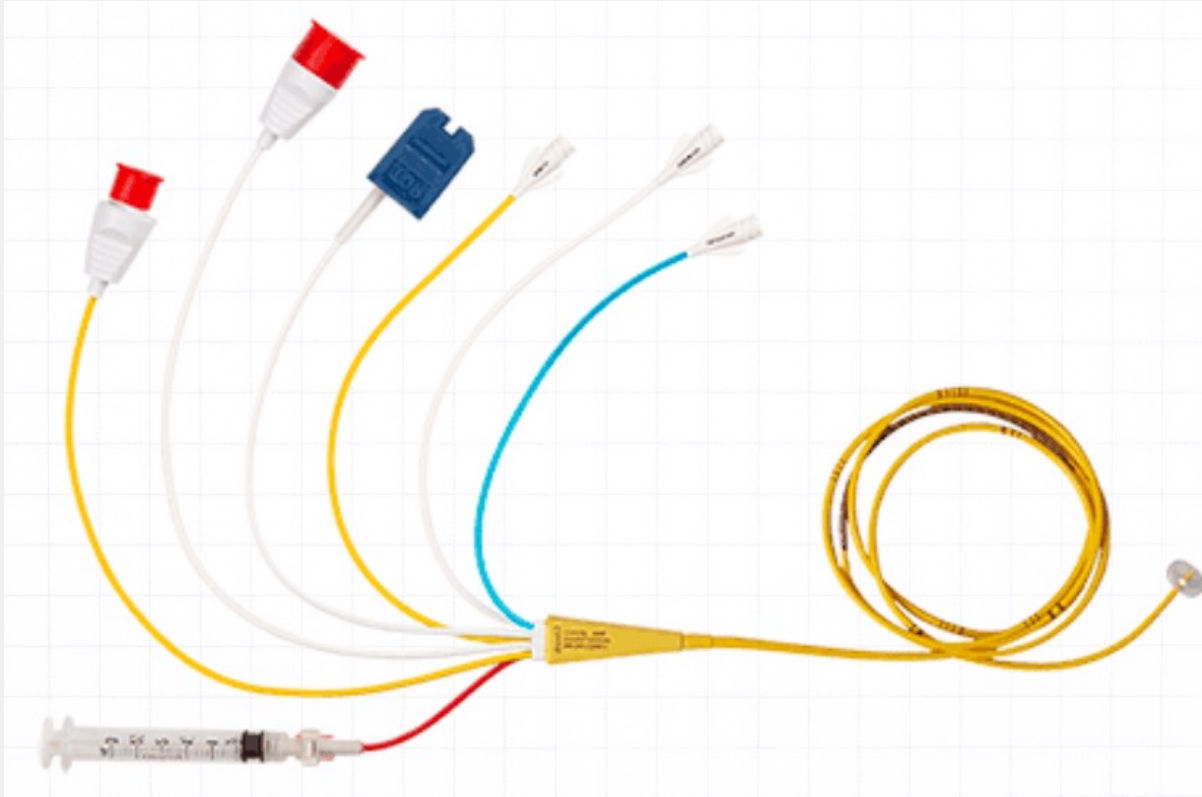
Garan, A.R. et al. J Am Coll Cardiol HF. 2020;8(11):903-13.

CENTRAL ILLUSTRATION: Pulmonary Artery Catheter Use in CICUs and Association With Mortality



Kadosh BS, et al. J Am Coll Cardiol HF. 2023;11(8):e003226.

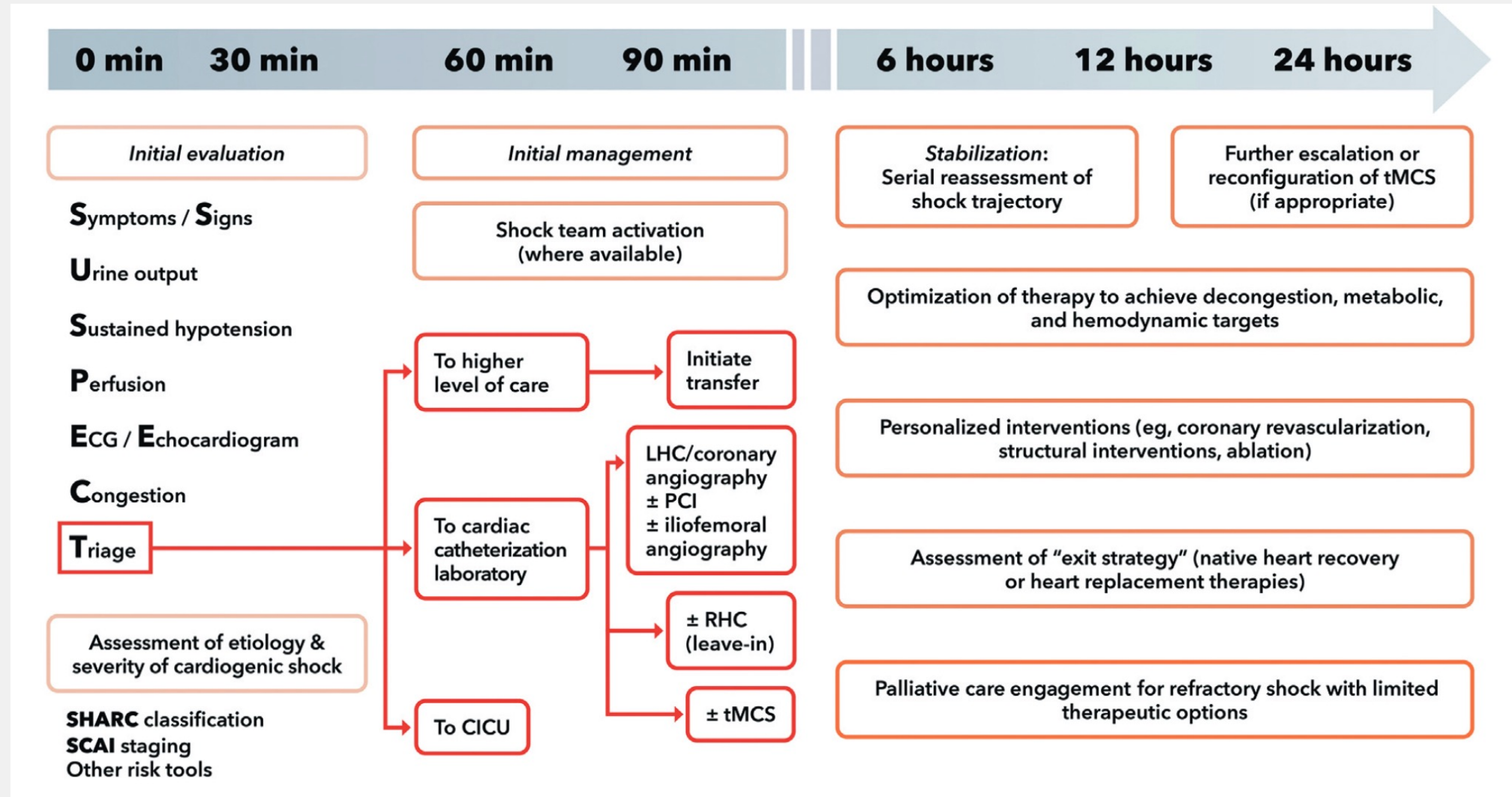
PACCS trial



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24-hour Roadmap to CS management



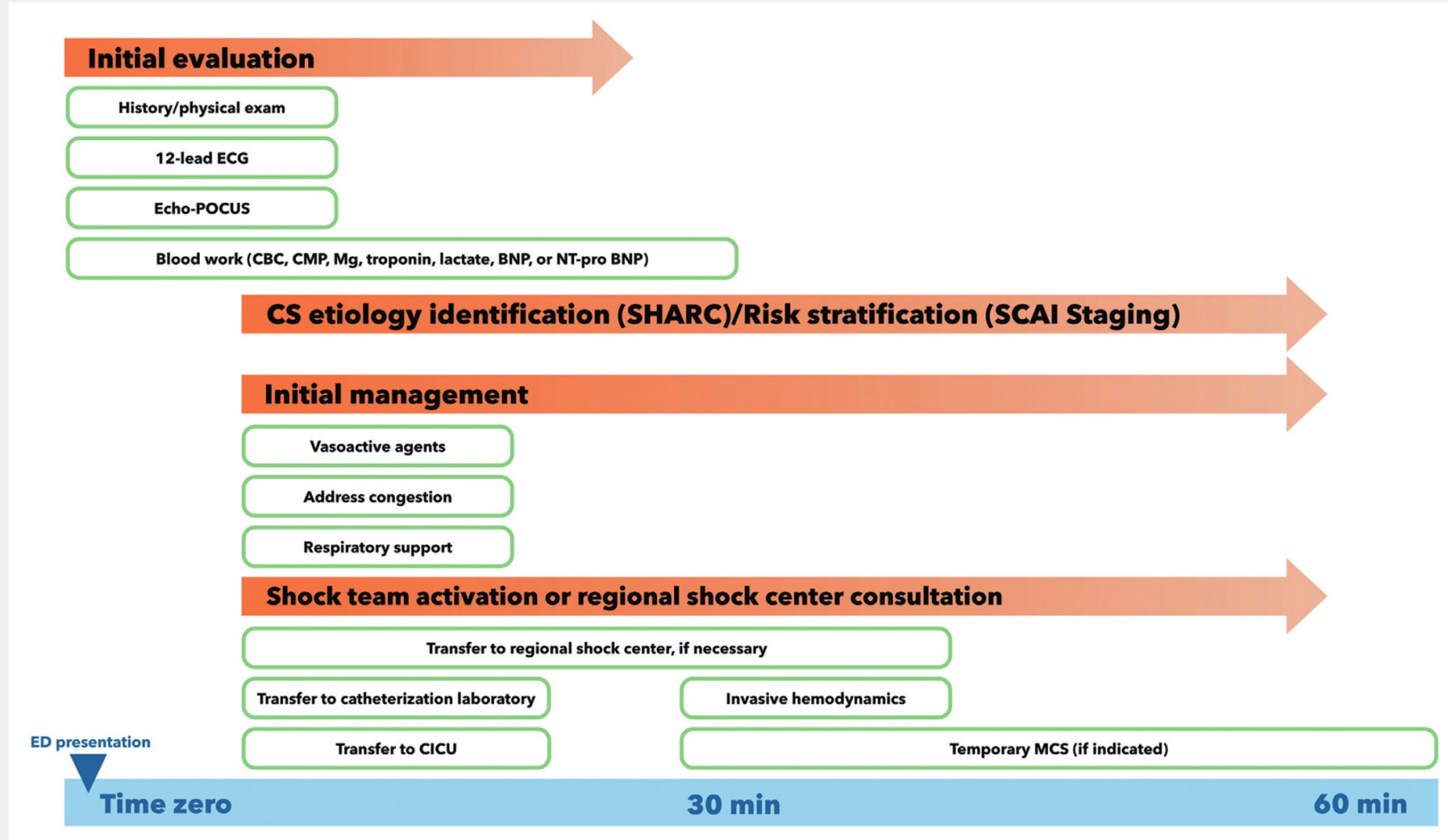
Sinha, S et al. *JACC*. 2025 Apr, 85 (16) 1618–1641.

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Golden Hour of Acute Cardiogenic Shock



Sinha, S et al. JACC. 2025 Apr, 85 (16) 1618–1641.

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Talk 2: Siddarth Pahwa



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Cardiogenic shock – A surgeon's perspective

Siddharth V. Pahwa, MD

Associate Professor

Division Chief, Adult Cardiac Surgery

University of Louisville, KY



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Disclosures

I do not have any relationships to report with ACCME defined ineligible companies.

I will not be discussing unlabeled/investigational uses of medical devices or pharmaceuticals during this presentation.



Goals of treatment

- Improve abnormal hemodynamics
- Maintain adequate tissue perfusion



Myriad of options available – How do you choose?

- What is the primary problem?
- Which ventricle is significantly involved?



SHORT-TERM MECHANICAL CIRCULATORY SUPPORT	PERCUTANEOUS OPTIONS	SURGICAL OPTIONS
Left-sided	•IABP (femoral or axillary) •Impella 2.5 (LV-Ao) •Impella CP (LV-Ao) •TandemHeart (LA-Ao)	•Axillary graft IABP via graft anastomoses •Impella 5.0 via axillary graft •Impella LD (direct arteriotomy of ascending aorta) •LV CentriMag (LV apical position)
Right-sided	•Impella RP (RV-PA) •TandemHeart (RA-PA) •ProtekDuo cannula with centrifugal pump (RA-PA)	•RV CentriMag (RV or RA-PA)
Biventricular	•Peripheral VA ECMO •Impella CP or 2.5 <i>plus</i> Impella RP •Impella CP or 2.5 <i>plus</i> TandemHeart (RA-PA) or ProtekDuo with centrifugal pump	•Central cannulation VA ECMO •Biventricular CentriMag



Left Ventricle

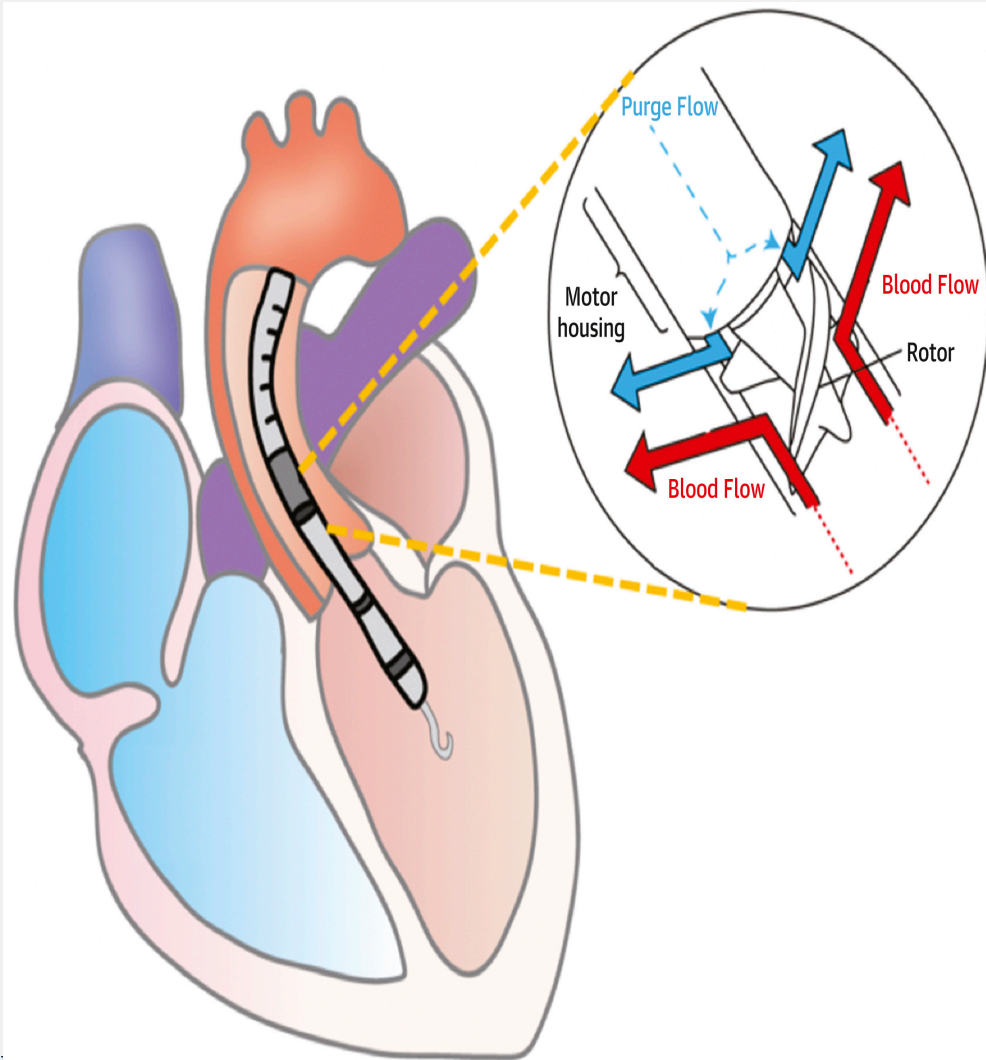
IABP

- Most commonly used modality of temporary MCS
- Decreases diastolic blood pressure, decreases afterload, decreases myocardial oxygen consumption
- Increases coronary perfusion
- IABP – Shock II study negative

- True cardiogenic shock – No benefit
- CI 1.8-2 on no inotropes – YES!!



Left Ventricle



Impella 5.5

- LV unloading, reduces LVEDP
- Decreases myocardial O₂ consumption
- Typically placed via the axillary artery (8 or 10 mm graft)
- Cardiogenic shock involving predominantly the LV or as part of ECPELLA

Left Ventricle

VA ECMO

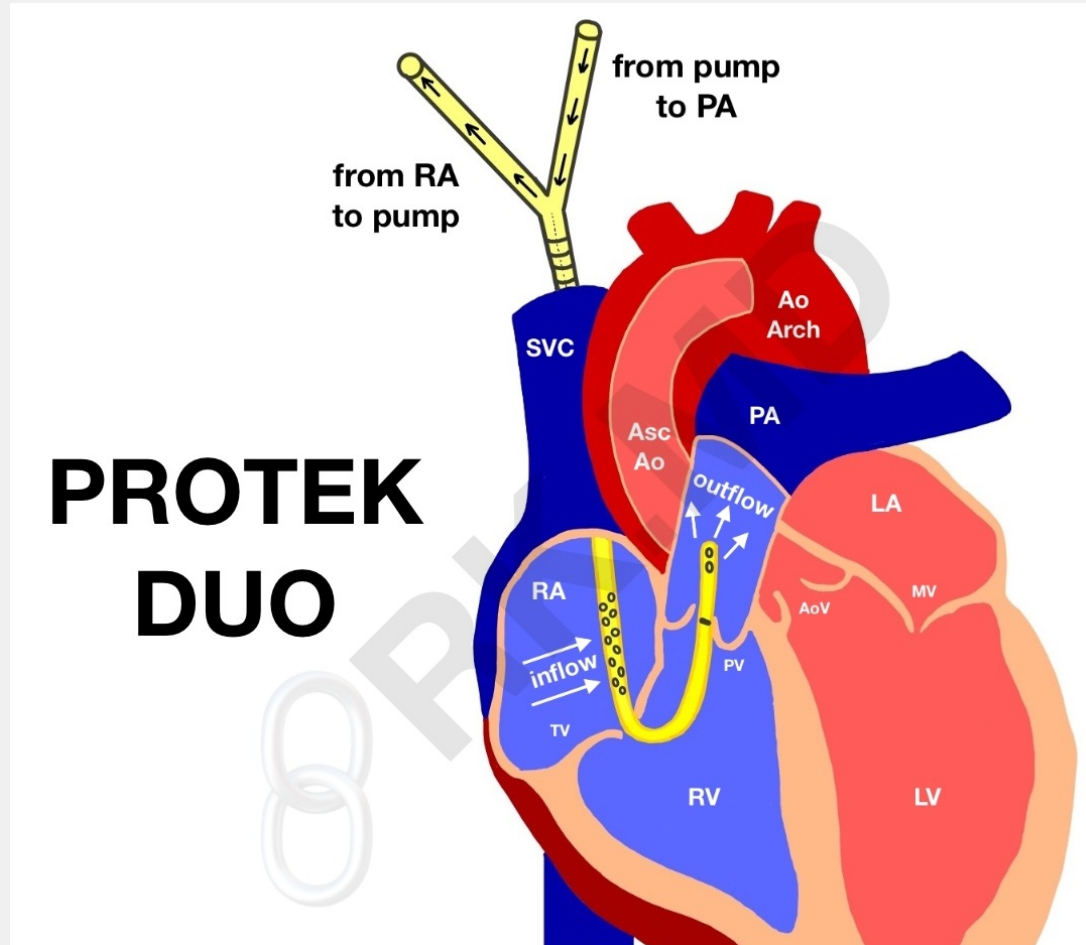
- Highest level of support
- Inserted percutaneously, or directly via a sternotomy
- Provides 4-6 liters/min flow
- Decompresses RV, increases LV afterload
- In cases with poor LV function (minimal contractility), LV vent is needed
- ECPELLA



Right Ventricle

Protek Duo

- Inserted via the IJV
- Drains blood from the RA and reinfuses into the PA
- Centriimag pump



Case Presentation

- 23 y/o F, peripartum cardiomyopathy, delivered 2 days ago
 - Arrested at OSH
 - CPR for 8 min, ROSC
 - Transferred to us
-
- On epi 0.1 mics/kg/min, nor epi 0.2 mics/kg/min and vaso at 4 U/min
 - Emergent Swan – CI 1.5 l/min/sq m
 - TEE – RV function moderately reduced, LVEF 5%



-
- Emergent Impella 5.5 via trans-axillary route
 - POD 1 – Sinus tach, HR 160-180/min
 - TEE – RV now severely depressed, Impella 5.5 in good position
 - Emergent Protek Duo via RIJ
 - Supported on Protek and Impella for 7 days, extubated
 - Listed for transplant
 - POD 8 – Orthotopic Heart Transplant
 - POD 16 – Discharged home



99 Patients
Impella 5.5

29 (29%)
Mortality during Impella 5.5

20 (20%)
Impella explant
Support 8 (4-14) days

17 (17%)
LVAD implant
Support 10 (7-13) days

33 (33%)
Heart Transplantation
Support 16 (13-25) days



Questions and Discussion

Talk 2: Jeffrey Spindel



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The Future of Critical Care Cardiology

Jeff Spindel, DO



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Disclosures

None



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Outline

Patient Population

- Diagnoses
- Comorbidities

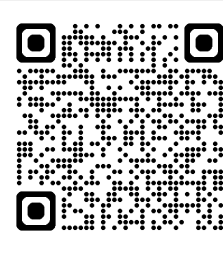
People

- Training
- Care Models

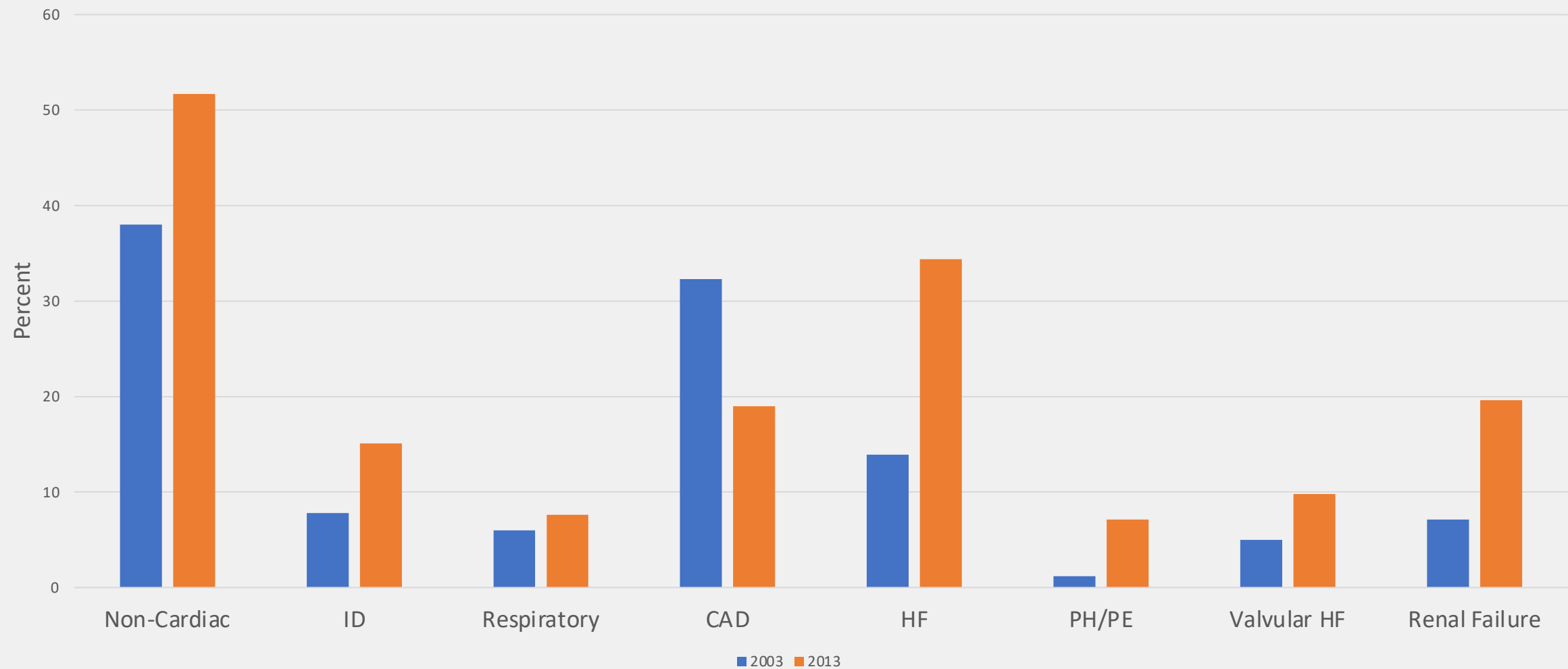
Systems

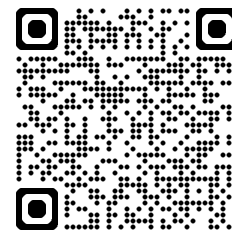
- Shock Teams
- Centers



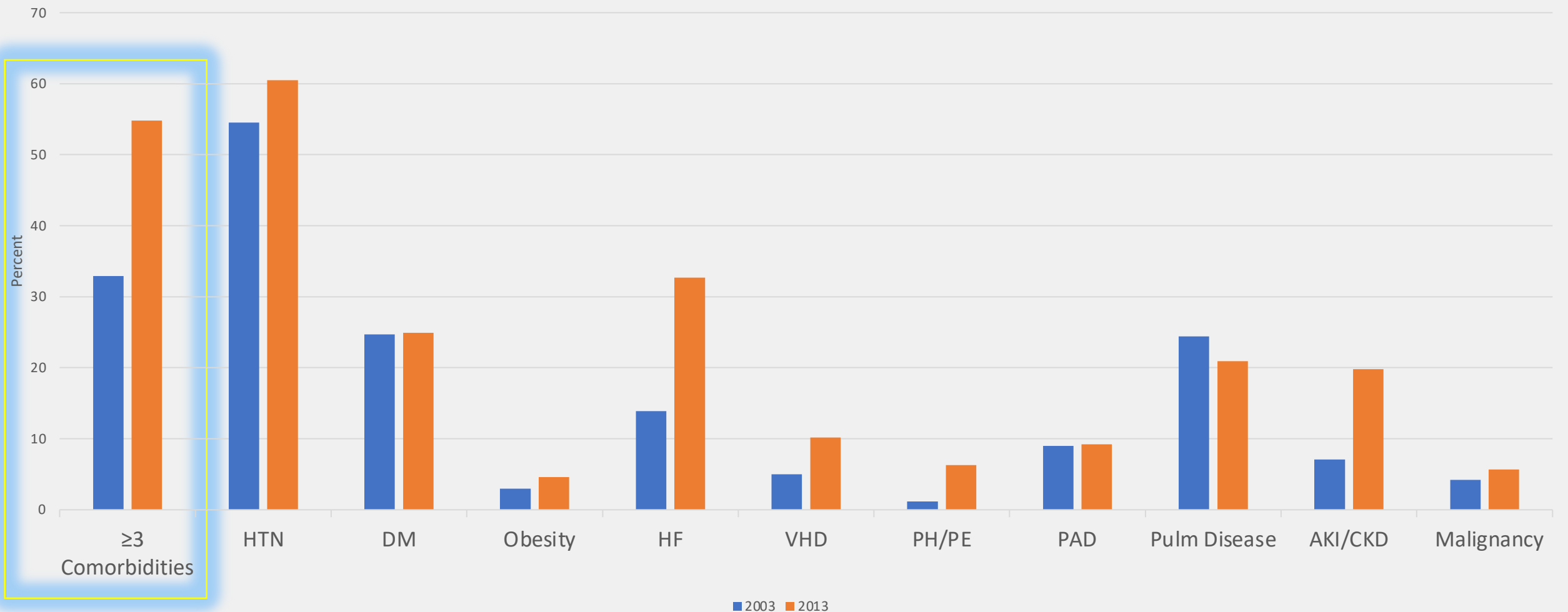


CICU Discharge Diagnosis





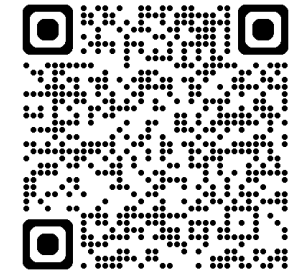
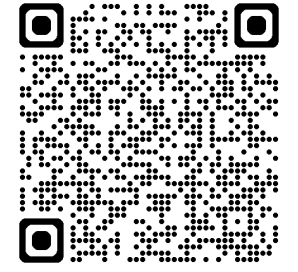
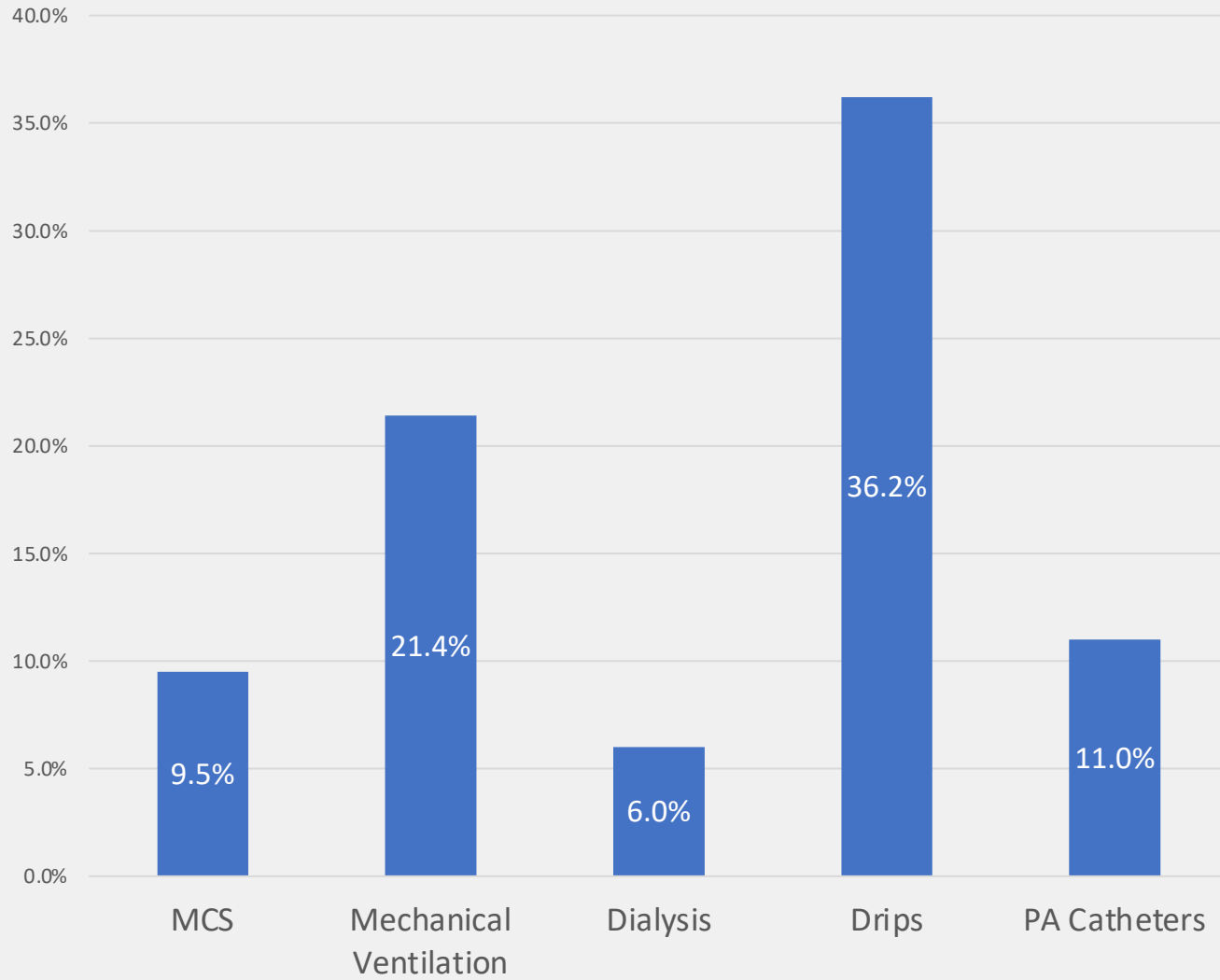
Comorbidities



■ 2003 ■ 2013



CICU Therapies and Treatment



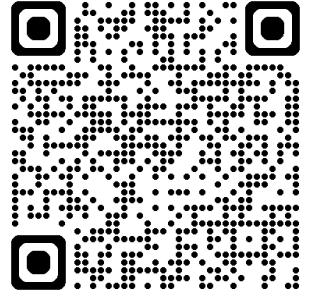
Changes in patient populations...



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...Requires changes in expertise



Training in Critical Care Cardiology Within Critical Care Medicine Fellowship



A Novel Pathway

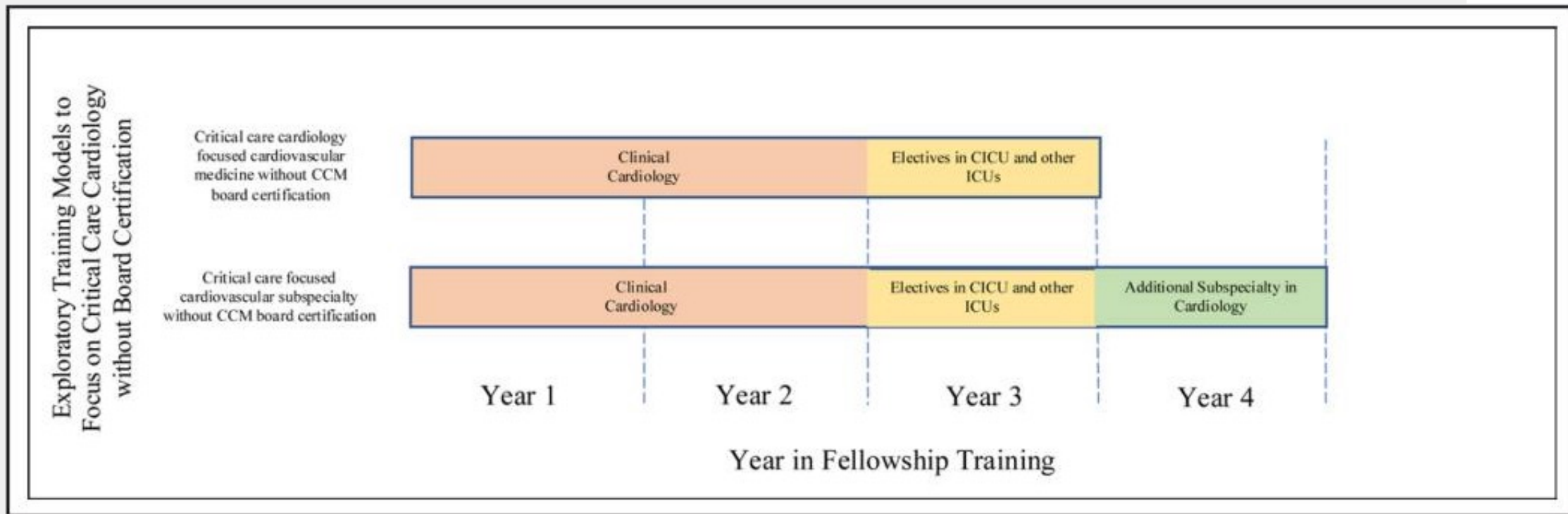
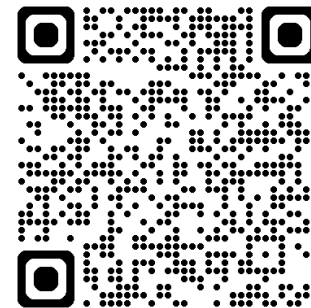
Connor G. O'Brien, MD,^a Christopher F. Barnett, MD, MPH,^a David M. Dudzinski, MD, JD,^b Pablo A. Sanchez, MD,^c
Jason N. Katz, MD, MHS,^d John G. Harold, MD,^e Erin K. Hennessey, MD,^f Paul K. Mohabir, MD^g

1. Airway/ventilator management
2. Management of mixed shock
3. Management of MCS
4. Familiarity with renal replacement therapy
5. Management of neurologic emergencies
6. Postoperative cardiac surgery management



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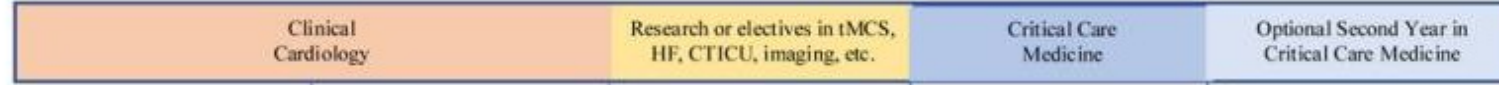
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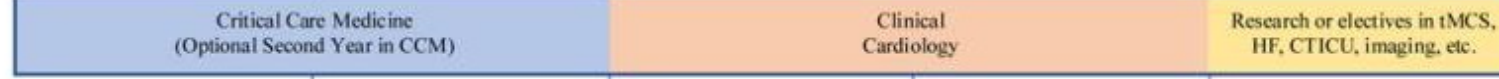
Training Models to Achieve Board Certification in Cardiovascular and Critical Care Medicine

Current Pathways

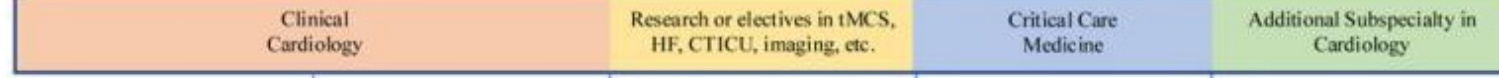
Cardiovascular medicine followed by CCM fellowship/board certification



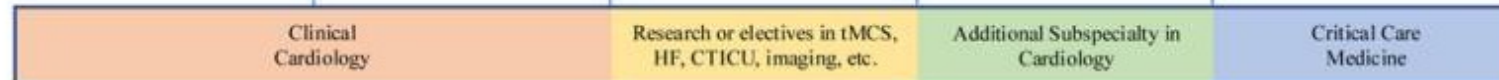
CCM fellowship/board certification followed by cardiovascular medicine



Multiple subspecialties with CCM fellowship/board certification

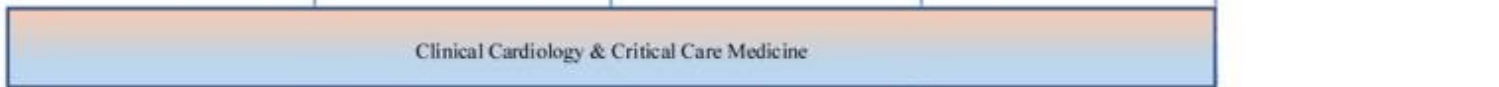


Multiple subspecialties with CCM fellowship/board certification



Possible Future Pathways

Integrated cardiovascular & CCM fellowship with board certification



Integrated cardiovascular & CCM fellowship with board certification and an additional subspecialty



Year 1

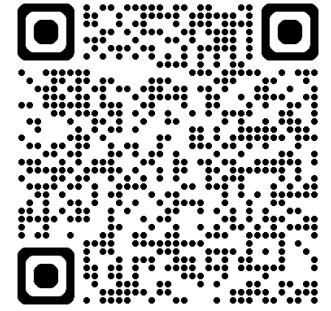
Year 2

Year 3

Year 4

Year 5

Year in Fellowship Training



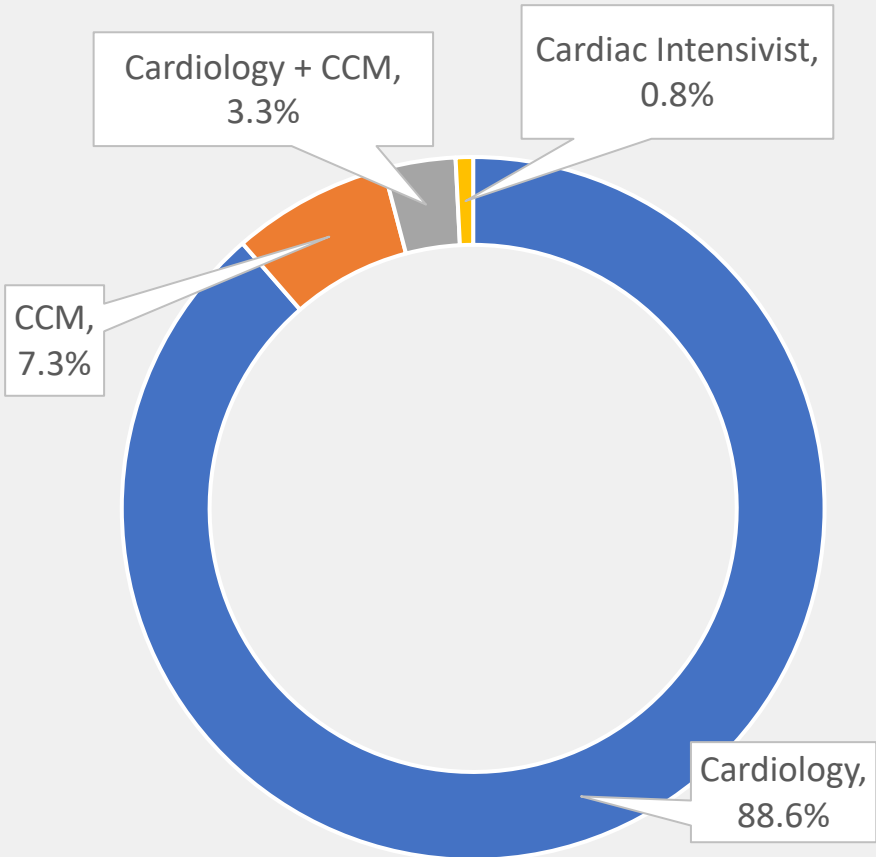
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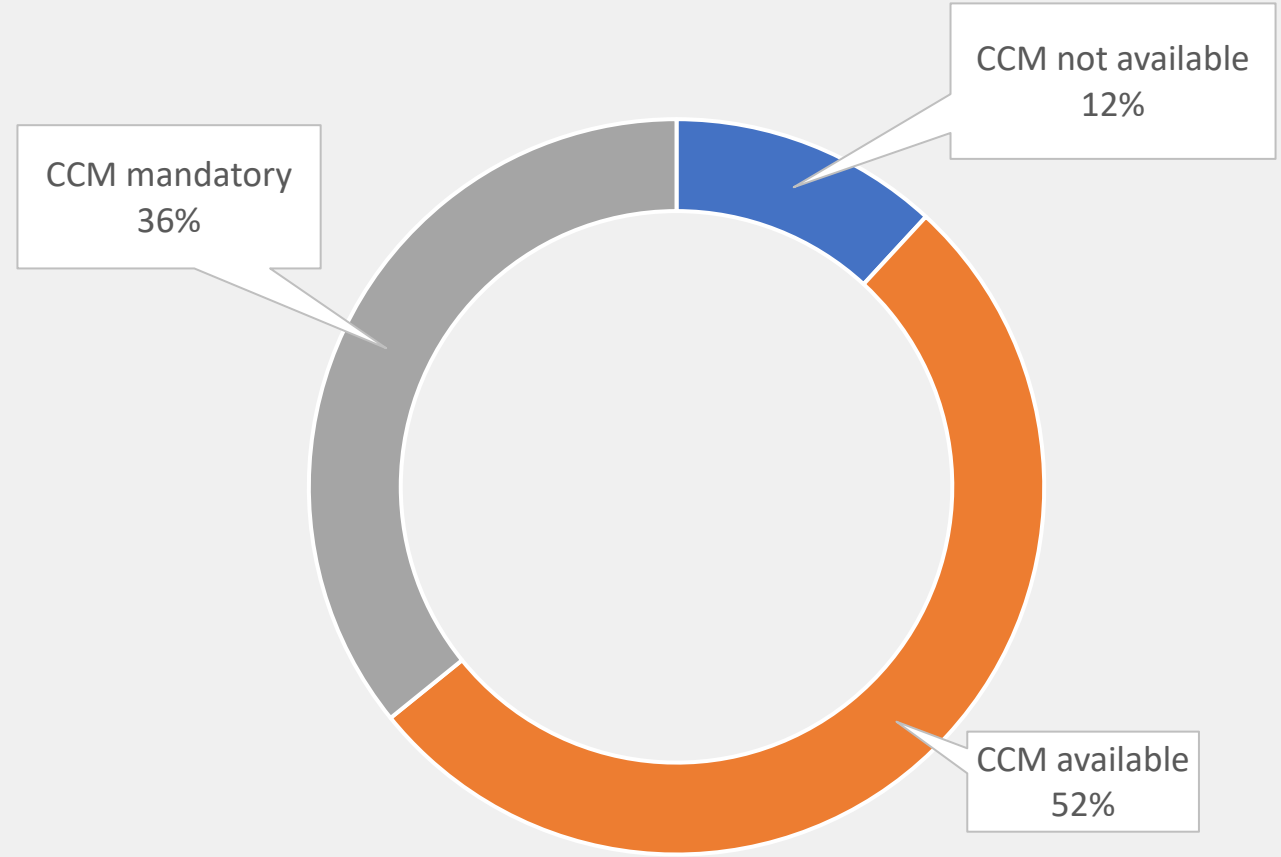
Staffing Models



Primary Physician

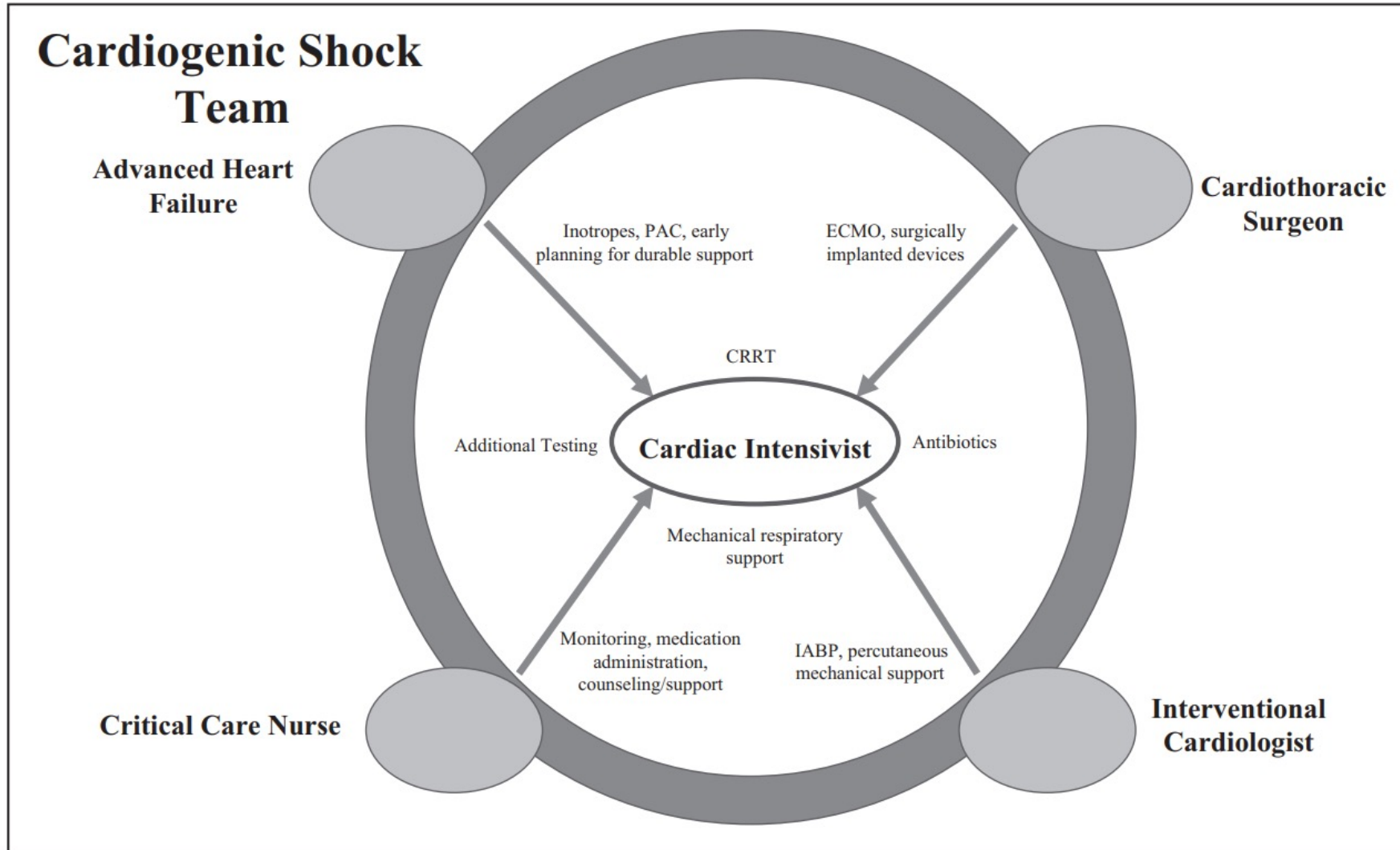
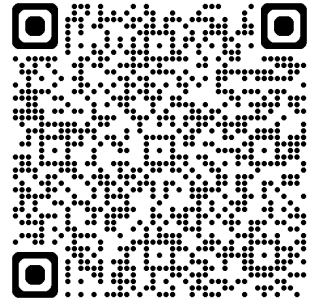


Consultations

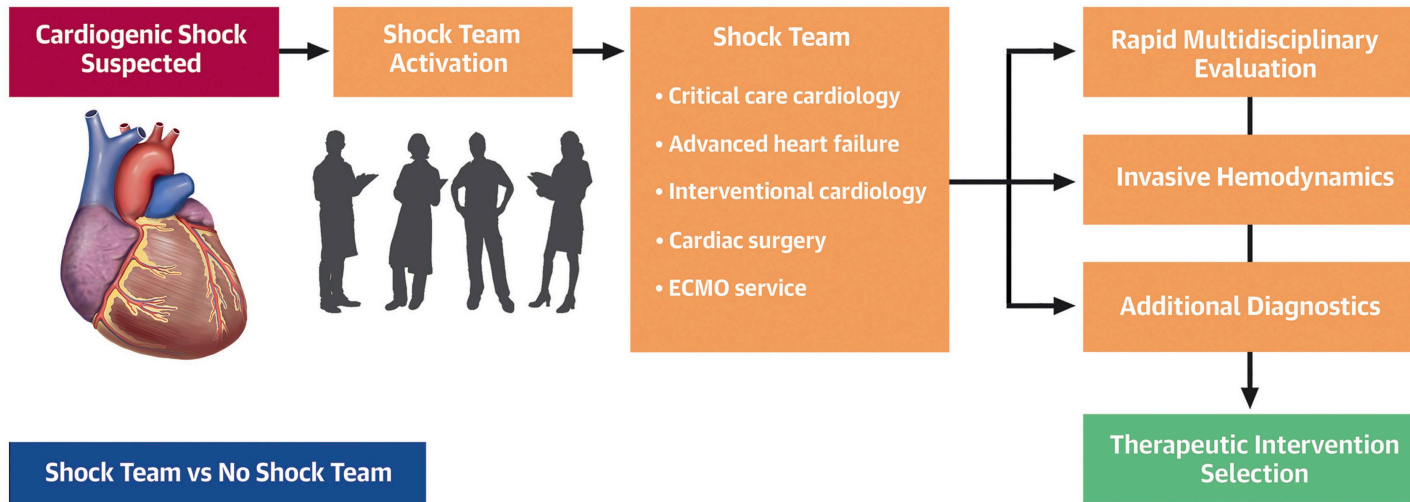


Intervention	Mortality	Cost	LOS	Reference
Closed Unit	✓			2
HF/CC Staffing	✓			3,4
24/7 Staffing	✓			5
Mandatory CC Consultation (IMV)		✓	✓	6
Shock Team	✓	✓	✓	7,8,9,10

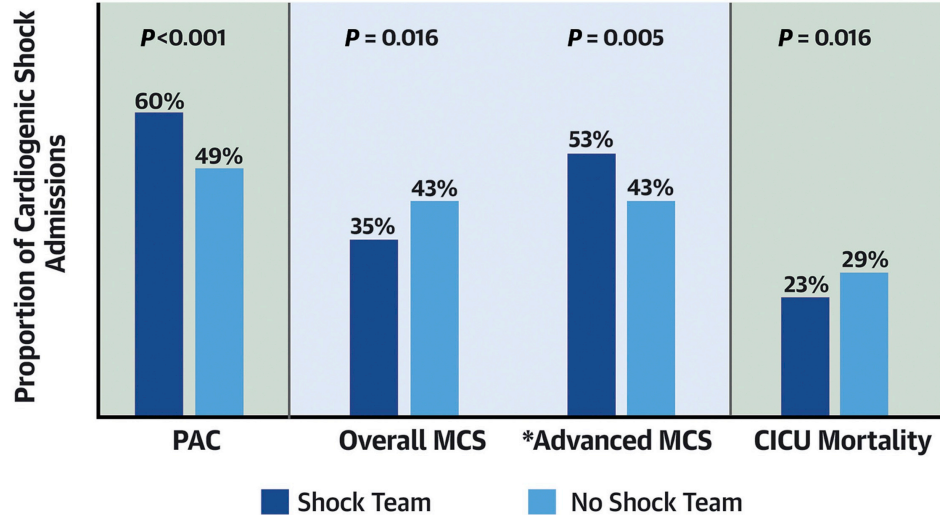
Shock Teams



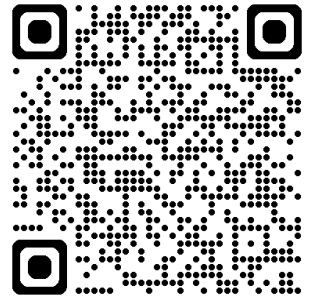
CENTRAL ILLUSTRATION: Prototypical Shock Team Workflow and Associated Outcomes



Shock Team vs No Shock Team Center Population Characteristics	
Cardiogenic shock admissions (n)	546 vs 696
AMI-CS (%)	27 vs 28
Admission lactate (mmol/L)	2.3 vs 2.3
PCWP (mm Hg)	25 vs 22
CI (L/min/m ²)	1.9 vs 2.0
CPO (W)	0.62 vs 0.64



Papolos, A.I. et al. J Am Coll Cardiol. 2021;78(13):1309-1317.



Lower mortality

- (23 vs 29%), aOR 0.72

Cost saving¹¹



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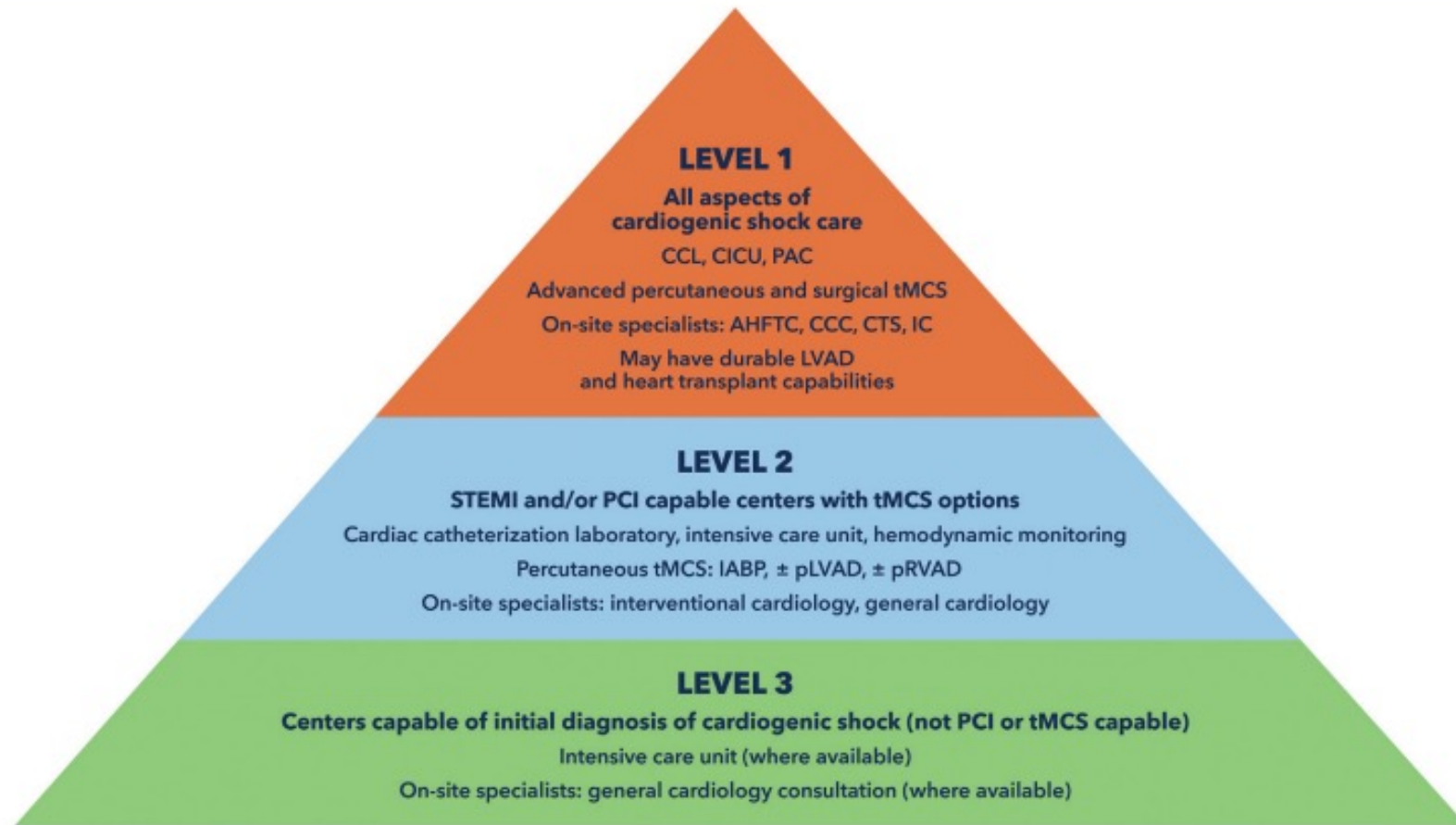
So, what is the future of CCC?



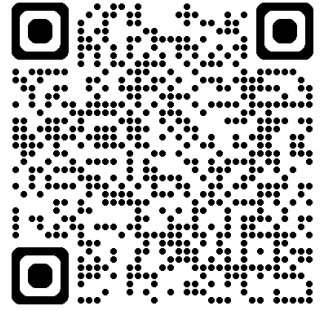
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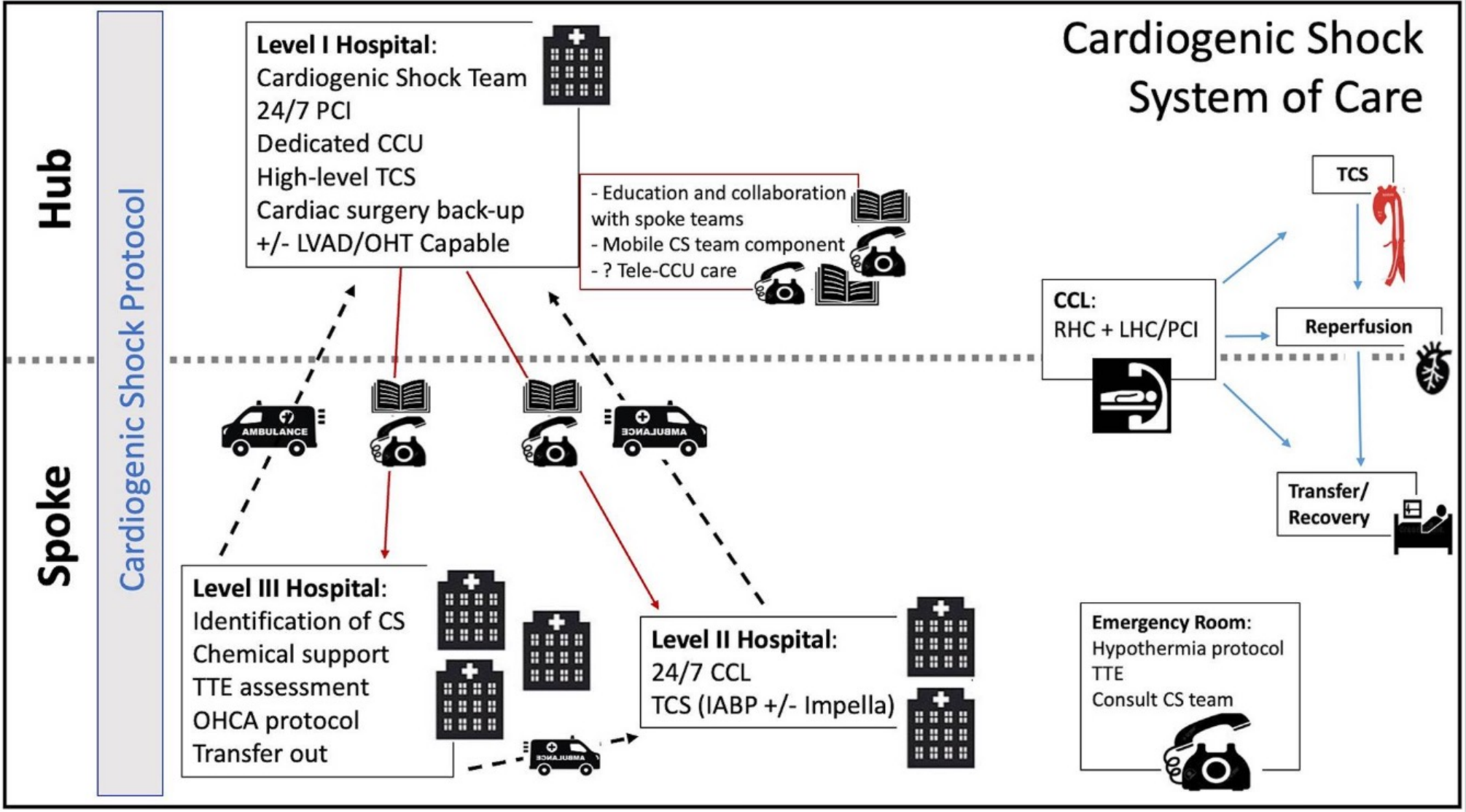
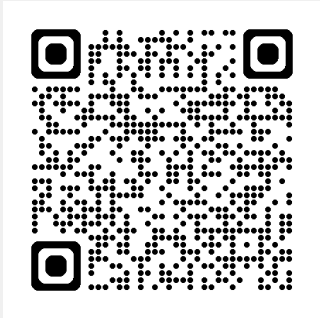
FIGURE 3 Proposed Classification of CS Centers of Care Based on Locally Available Resources and Expertise



AHFTC = advanced heart failure and transplant cardiology; CCC = critical care cardiology; CCL = cardiac catheterization laboratory; CICU = cardiac intensive care unit; CTS = cardiothoracic surgery; IABP = intra-aortic balloon pump; IC = interventional cardiology; LVAD = left ventricular assist device; PAC = pulmonary artery catheter; PCI = percutaneous coronary intervention; pLVAD = percutaneous left ventricular assist device; pRVAD = percutaneous right ventricular assist device; STEMI = ST-segment elevation myocardial infarction; tMCS = temporary mechanical circulatory support.



Systems of Care



Intraaortic Balloon Support for Myocardial Infarction with Cardiogenic Shock

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The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Extracorporeal Life Support in Infarct-Related Cardiogenic Shock

H. Thiele, U. Zeymer, J. Alkin, M. Behr, T. Basse, A. A. Mahabadi, P. Lehmann, P. Clemens, S. Ewer, T. Goslar

ORIGINAL CONTRIBUTION

JAMA-EXPRESS

Extracorporeal Membrane Oxygenation for Cardiogenic Shock

The NEW ENGLAND JOURNAL of MEDICINE

Effect of Extracorporeal Life Support With Acute Myocardial Infarction and Cardiogenic Shock

The TRIUMPH Randomized Controlled Trial

Percutaneous Mechanical Circulatory Support Versus Intra-Aortic Balloon Pump for Cardiogenic Shock After Acute Myocardial Infarction

tially.¹ However, cardiogenic shock (CS) may occur prior to or following reperfusion. Even those who survive acute intervention may later develop CS and the overall 30-day mortality for patients with CS in association with MI is approximately 40–50%. Unfortunately, this incidence has not changed in the past 20 years since the publication of the landmark SHOCK (SHould we emergently revascularize Occluded Coronaries for cardiogenic shock) trial.^{2–5}

ORIGINAL RESEARCH ARTICLE

and patients aged >75 years.⁹ The incidence of CS has increased in recent years, while the reason for increasing incidence is unclear, improved diagnosis and better access to care are both likely contributory.⁹ While the in-hospital mortality has improved,¹ the 6- to 12-month mortality in cardiogenic shock has remained unchanged at ≈50% over the past 2 decades.^{3, 4, 11}

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Future of Critical Care Cardiology

Patients

- More comorbid
- More non-cardiac illnesses
- More IMV
- More RRT

People

- Expanded CCC interest and training opportunities
- Designated staffing

Systems

- Dedicated Units
- Multidisciplinary Shock Teams
- Interhospital communication and escalation



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