ECMO in Cardiogenic Shock Of Course, YES….

Alain Combes, MD, PhD

Cardiology Institute, Hôpital Pitié-Salpêtrière, AP-HP
Inserm UMRS 1166, iCAN, Institute of Cardiometabolism and Nutrition
Sorbonne Université, Paris, France
www.paris-ecostcs.com
alain.combes@aphp.fr

ICAN Institute of Cardiometabolism And Nutrition TOGETHER

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- Principal Investigator:
  - EOLIA trial, VV ECMO in ARDS
    - *NCT01470703, Partly sponsored by MAQUET, Getinge Group*
  - ANCHOR trial, VA ECMO in AMI-CS
    - *NCT04184635, Partly sponsored by MAQUET, Getinge Group*
- Received honoraria for lectures and consulting from
  - MAQUET, BAXTER, XENIOS

ECMO for Refractory CS in AMI Patients

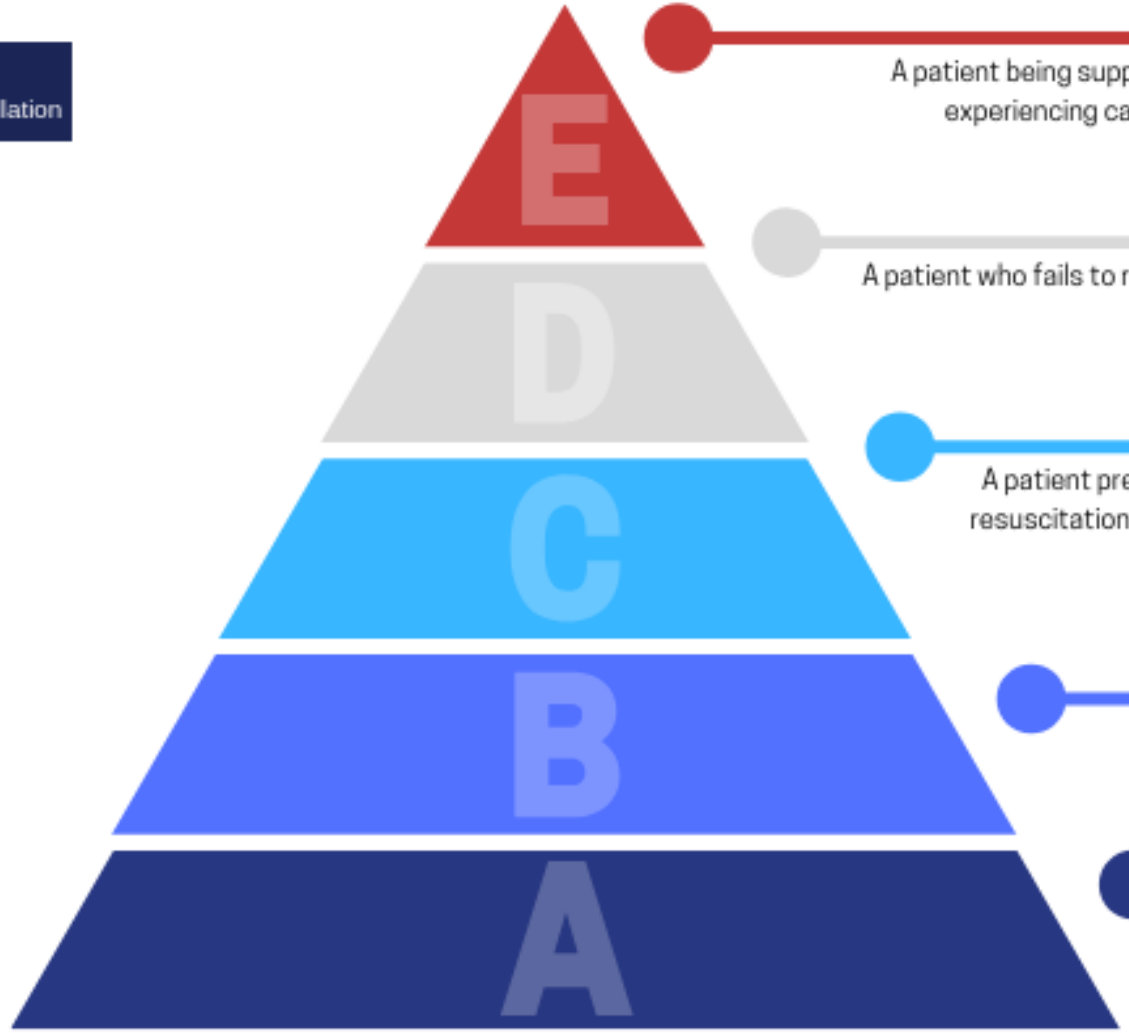
Selecting the adequate population of patients…

SCAI
Society for Cardiovascular Angiography & Interventions

SCAI Stages of Cardiogenic Shock

Adapted from the SCAI Clinical Expert Consensus Statement on the Classification of Cardiogenic Shock
Endorsed by ACC, AHA, SCCM, and STS

Arrest (A) Modifier:
CPR, including defibrillation



EXTREMIS

A patient being supported by multiple interventions who may be experiencing cardiac arrest with ongoing CPR and/or ECMO.

DETERIORATING

A patient who fails to respond to initial interventions. Similar to stage C and getting worse.

CLASSIC

A patient presenting with hypoperfusion requiring intervention beyond volume resuscitation (inotrope, pressor, or mechanical support including ECMO). These patients typically present with relative hypotension.

BEGINNING

A patient who has clinical evidence of relative hypotension or tachycardia without hypoperfusion.

AT RISK

A patient with risk factors for cardiogenic shock who is not currently experiencing signs or symptoms. For example, large acute myocardial infarction, prior infarction, acute and/or acute on chronic heart failure.

ECMO

Baran DA, Grines CL, Bailey S, et al. SCAI clinical expert consensus statement on the classification of cardiogenic shock. Catheter Cardiovasc Interv. 2019;1–9. https://doi.org/10.1002/ccd.28329
For more information, please visit: www.scai.org/shockdefinition

SCAI SHOCK Stage Classification Expert Consensus Update:

JACC VOL. 79, NO. 9, 2022

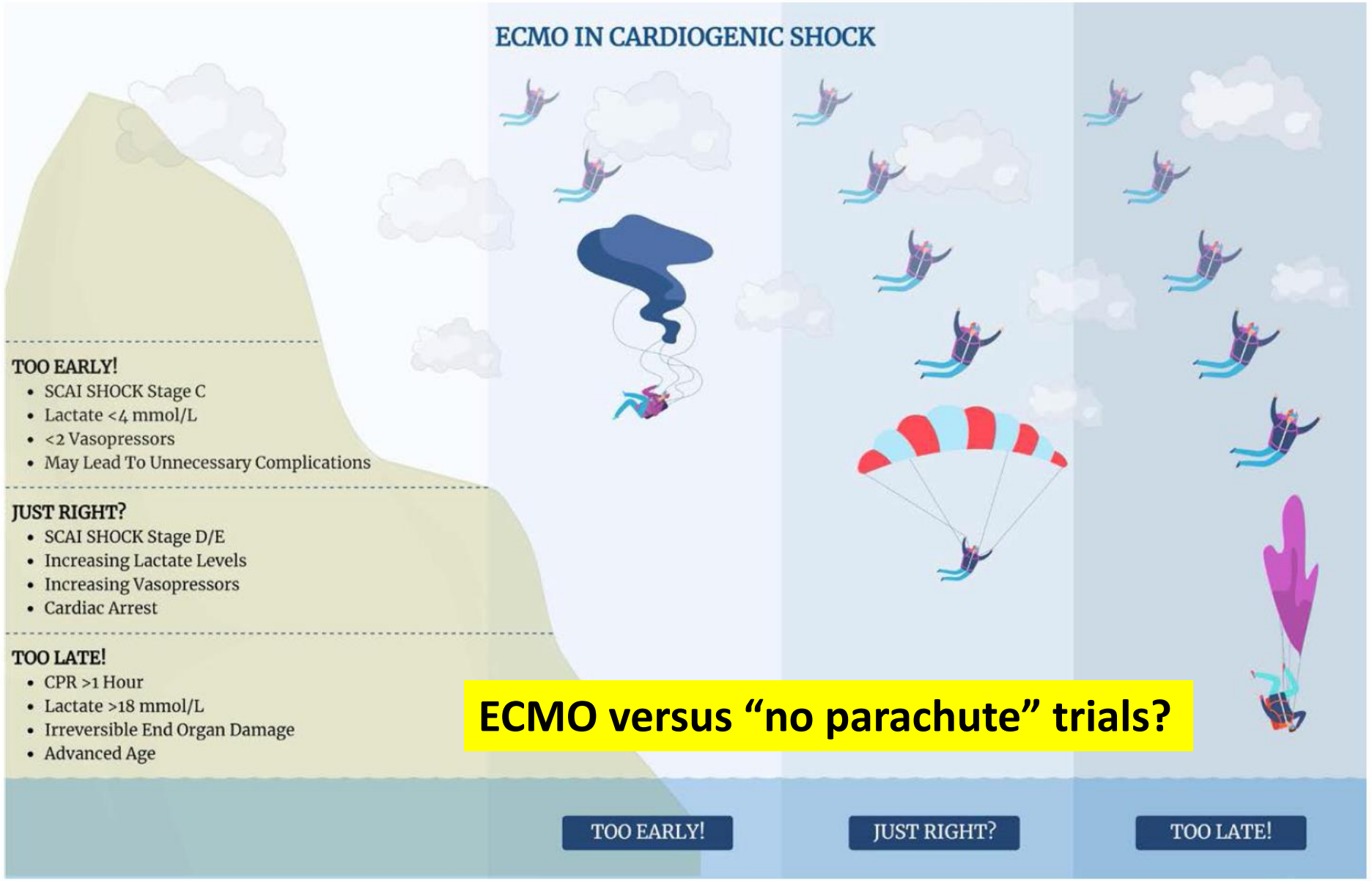
C Classic CS	A patient who manifests with **hypoperfusion and who requires one intervention (pharmacological or mechanical) beyond volume resuscitation**. These patients typically present with relative hypotension (but hypotension is not required).	**Volume overload**	Looks unwell Acute alteration in mental status Feeling of impending doom Cold and clammy Extensive rales Ashen, mottled, dusky, or cool extremities Delayed capillary refill Urine Output <30 mL/h	**Lactate ≥2 mmol/L**	Creatinine increase to 1.5 x baseline (or 0.3 mg/dL) or >50% drop in GFR Increased LFTs Elevated BNP	If invasive hemodynamics assessed (**strongly recommended**) • Cardiac index <2.2 L/min/m^2 • PCWP >15 mmHg

SCAI SHOCK Stage Classification Expert Consensus Update:

JACC VOL. 79, NO. 9, 2022

		Physical examination/ bedside findings		Biochemical markers		Hemodynamics	
Stage	**Description**	**Typically includes**	**May include**	**Typically includes**	**May include**	**Typically includes**	**May include**
D Deteriorating	A patient who is similar to category C but is getting worse. **Failure of initial support strategy to restore perfusion** as evidenced by worsening hemodynamics or rising lactate.	**Any of stage C and worsening (or not improving) signs/ symptoms of hypoperfusion despite the initial therapy.**		**Any of stage C and lactate rising and persistently >2 mmol/L**	Deteriorating renal function Worsening LFTs Rising BNP	**Any of stage C and requiring escalating doses or increasing numbers of pressors or addition of a mechanical circulatory support device to maintain perfusion** If invasive hemodynamics assessed (**strongly recommended**) • Cardiac index <2.2 L/min/m^2 • PCWP >15 mmHg	
E Extremis	**Actual or impending circulatory collapse**	**Typically unconscious**	Near pulselessness Cardiac collapse Multiple defibrillations	**Lactate ≥8 mmol/L**[a]	CPR (A-modifier) Severe acidosis • pH <7.2 • Base deficit >10 mEq/L	**Profound hypotension despite maximal hemodynamic support**	Need for bolus doses of vasopressors

Circulation. 2023;147:465–468. DOI: 10.1161/CIRCULATIONAHA.122.063190



ECMO versus “no parachute” trials?

Good timing for VA-ECMO…

Association Between Timing of Extracorporeal Membrane Oxygenation and Clinical Outcomes in Refractory Cardiogenic Shock

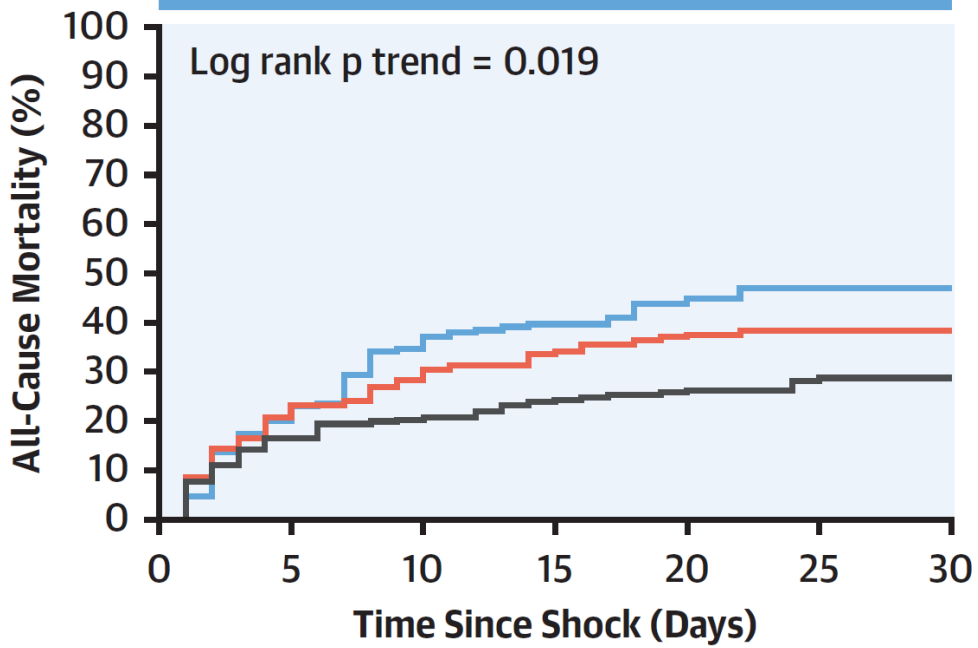
Hyeok-Hee Lee, MD,[a,b] Hyeon Chang Kim, MD, PhD,[a,b] Chul-Min Ahn, MD, PhD,[b] Seung-Jun Lee, MD, PhD,[b] Sung-Jin Hong, MD, PhD,[b] Jeong Hoon Yang, MD, PhD,[c] Jung-Sun Kim, MD, PhD,[b] Byeong-Keuk Kim, MD, PhD,[b] Young-Guk Ko, MD, PhD,[b] Donghoon Choi, MD, PhD,[d] Hyeon-Cheol Gwon, MD, PhD,[c] Myeong-Ki Hong, MD, PhD,[b] Yangsoo Jang, MD, PhD[b]

METHODS From a multicenter registry, 362 patients with refractory CS who underwent ECMO between January 2014 and December 2018 were identified. Participants were classified into 3 groups according to tertiles of shock-to-ECMO time (early, intermediate, and late ECMO). Inverse probability of treatment weighting was conducted to adjust for baseline differences among the groups, followed by a weighted Cox proportional hazards regression analysis to calculate hazard ratios and 95% confidence intervals for 30-day mortality associated with each ECMO time group.

RESULTS The overall 30-day mortality rate was 40.9%. The risk for 30-day mortality was lower in the early group than in the late group (hazard ratio: 0.53; 95% confidence interval: 0.28 to 0.99). Early ECMO support was also associated with lower risk for in-hospital mortality, ECMO weaning failure, composite of all-cause mortality or rehospitalization for heart failure at 1 year, all-cause mortality at 1 year, and poor neurological outcome at discharge. However, the incidence of adverse events, including stroke, limb ischemia, ECMO-site bleeding, and gastrointestinal bleeding, did not differ significantly among the groups.

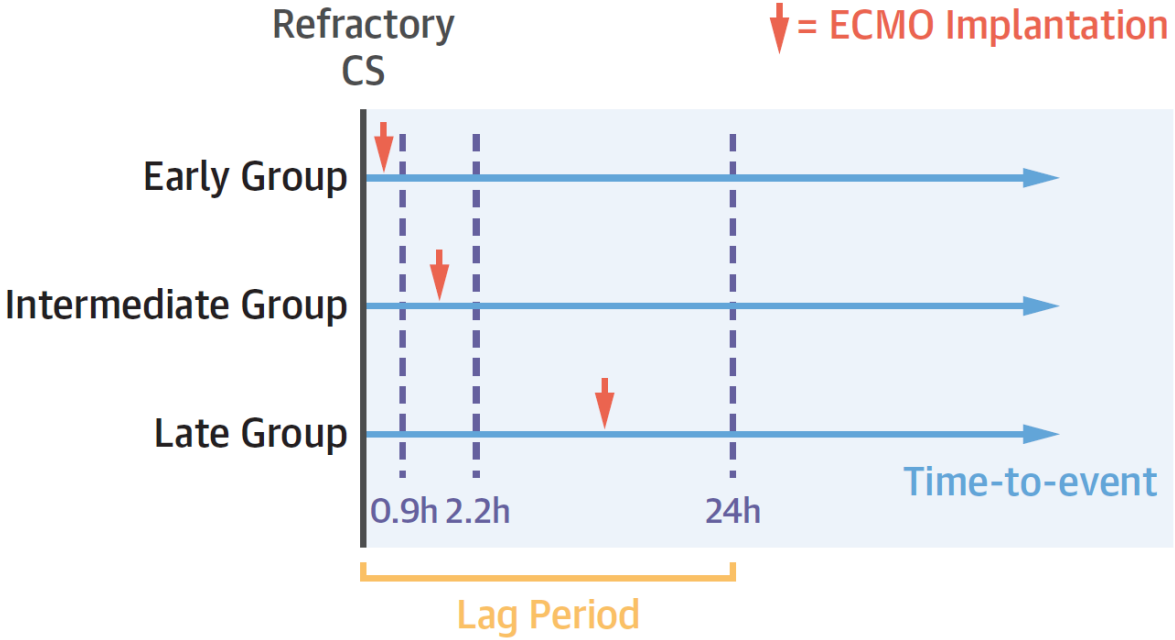
C

All-Cause Mortality According to ECMO Time Group



No. at risk:							
Late Group	83	66	53	46	43	40	40
Intermediate Group	102	81	73	68	64	61	60
Early Group	84	70	67	63	61	57	57

Analytic Design of the Study



Latest RCTs of ECMO

Did ECLS-Shock close the debate?

ORIGINAL ARTICLE

Extracorporeal Life Support in Infarct-Related Cardiogenic Shock

H. Thiele, U. Zeymer, I. Akin, M. Behnes, T. Rassaf, A.A. Mahabadi, R. Lehmann, I. Eitel, T. Graf, T. Seidler, A. Schuster, C. Skurk, D. Duerschmied, P. Clemmensen, M. Hennersdorf, S. Fichtlscherer, I. Voigt, M. Seyfarth, S. John, S. Ewen, A. Linke, E. Tigges, P. Nordbeck, L. Bruch, C. Jung, J. Franz, P. Lauten, T. Goslar, H.-J. Feistritzer, J. Pöss, E. Kirchhof, T. Ouarrak, S. Schneider, S. Desch, and A. Freund, for the ECLS-SHOCK Investigators*

N Engl J Med 2023

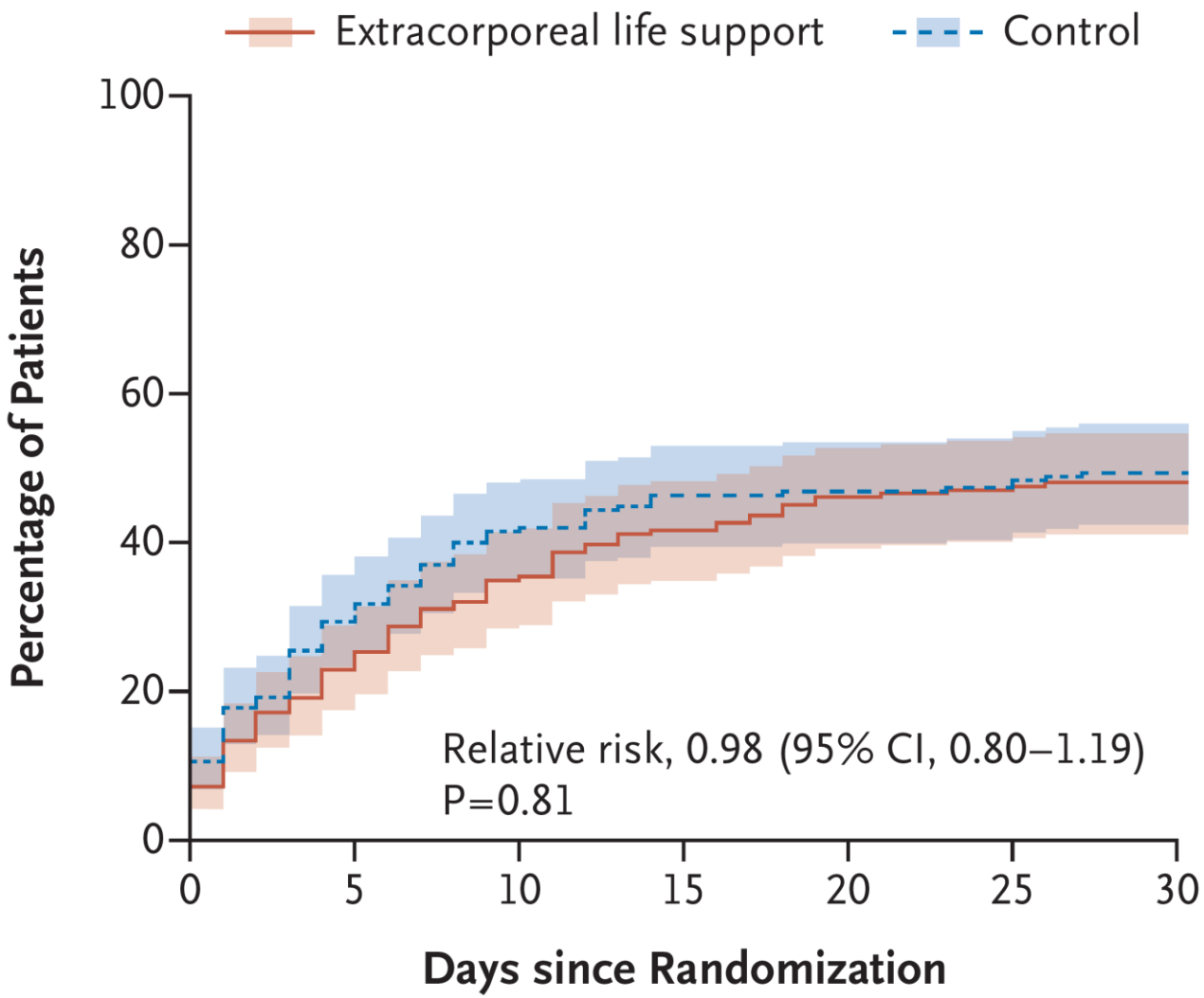
ABSTRACT

BACKGROUND

Extracorporeal life support (ECLS) is increasingly used in the treatment of infarct-related cardiogenic shock despite a lack of evidence regarding its effect on mortality.

Outcome	ECLS (N=209)	Control (N=208)	Effect Size (95% CI)*
Primary outcome			
Death from any cause — no. (%)	100 (47.8)	102 (49.0)	Relative risk, 0.98 (0.80 to 1.19)
Secondary outcomes			
Renal-replacement therapy — no. (%)	17 (8.1)	29 (13.9)	Relative risk, 0.58 (0.33 to 1.03)
Repeat revascularization — no. (%)	18 (8.6)	22 (10.6)	Relative risk, 0.81 (0.45 to 1.47)
Myocardial reinfarction — no. (%)	2 (1.0)	2 (1.0)	Relative risk, 1.00 (0.07 to 12.72)†
Rehospitalization for congestive heart failure — no. (%)	3 (1.4)	2 (1.0)	Relative risk, 1.49 (0.24 to 13.61)†
Poor neurologic outcome, CPC 3 or 4 — no./total no. (%)‡	27/109 (24.8)	24/106 (22.6)	Relative risk, 1.03 (0.88 to 1.19)
Median duration of invasive mechanical ventilation (IQR) — days	7.0 (4.0 to 12.0)	5.0 (3.0 to 9.0)	HLE, 1 (0 to 2)
Median time until hemodynamic stabilization (IQR) — days	3.1 (1.2 to 6.6)	3.1 (1.2 to 5.4)	HLE, 0.27 (–0.41 to 1.14)
Median duration of catecholamine therapy (IQR) — days	5.0 (2.5 to 8.0)	4.0 (2.0 to 7.0)	HLE, 1 (0 to 1)

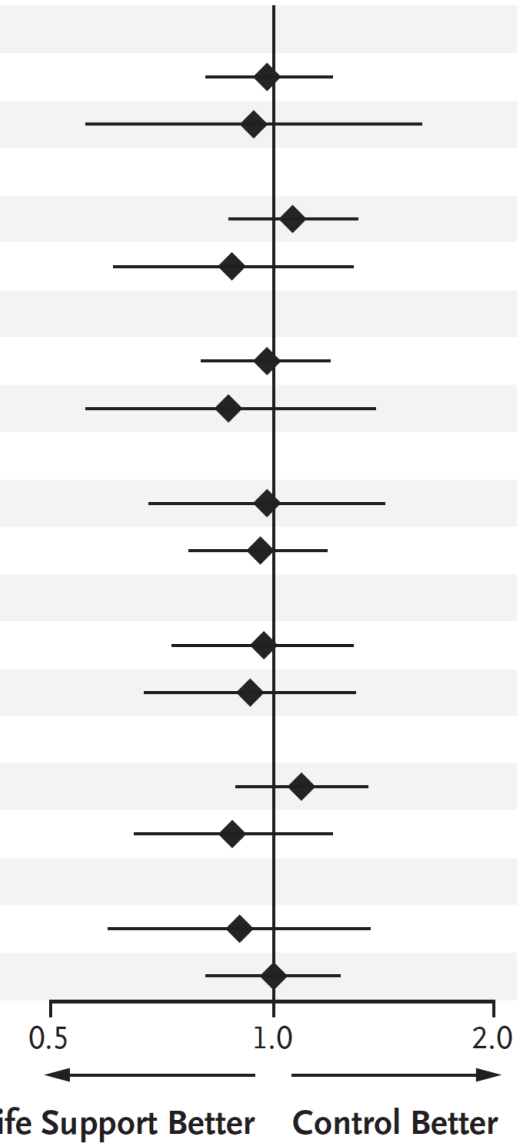
Day 30



No. at Risk

Control	208	146	120	109	105	104	100
Extracorporeal life support	209	161	136	119	109	107	105

Subgroup	Death from Any Cause at 30 Days	
	Control	Extracorporeal Life Support
	no. of patients with events/total no. of patients (%)	
Sex		
Male	79/169 (46.7)	78/170 (45.9)
Female	23/39 (59.0)	22/39 (56.4)
Age		
<65 yr	41/112 (36.6)	50/124 (40.3)
≥65 yr	61/96 (63.5)	50/85 (58.8)
Diabetes		
No	62/146 (42.5)	57/138 (41.3)
Yes	39/60 (65.0)	42/70 (60.0)
Type of infarction		
Non–ST-segment elevation myocardial infarction	36/66 (54.5)	37/69 (53.6)
ST-segment elevation myocardial infarction	65/141 (46.1)	59/135 (43.7)
ST-segment elevation myocardial infarction type		
Anterior infarction	39/85 (45.9)	33/75 (44.0)
Nonanterior infarction	26/56 (46.4)	25/59 (42.4)
Arterial lactate		
≤6 mmol/liter	24/85 (28.2)	30/87 (34.5)
>6 mmol/liter	75/120 (62.5)	69/120 (57.5)
CPR		
No	24/46 (52.2)	22/47 (46.8)
Yes	78/162 (48.1)	78/162 (48.1)



Should VA-ECMO be abandoned?…

Careful analysis of ECLS-SHOCK:
All is about patients selection/management…

25-30% of control group patients will be rescued by cross-over to t-MCS

Virtually no chance to demonstrate a benefit within a RCT…

Characteristic	ECLS (N = 209)	Control (N = 208)
ECLS therapy — no. (%)	192 (91.9)	26 (12.5)
Initiation in catheterization laboratory		
Before revascularization	42/192 (21.9)	4/26 (15.4)
During revascularization	50/192 (26.0)	8/26 (30.8)
	/192 (52.1)	7/26 (26.9)
	0/192	3/26 (11.5)
	0/192	4/26 (15.4)
	7 (1.5–4.8)	2.7 (2.2–3.8)
	/192 (95.3)	16/19 (84.2)
	7 (15–18)	17 (15–17)
Active left ventricular unloading during ECLS therapy — no./total no. (%)	11/191 (5.8)	6/19 (31.6)
Other mechanical circulatory support in patients without ECLS — no./total no. (%)	0/17	28/182 (15.4)
Intraaortic balloon pump	—	1/28 (3.6)
Impella 2.5	—	1/28 (3.6)
Impella CP	—	24/28 (85.7)
Impella 5.0	—	1/28 (3.6)
Impella 5.5	—	1/28 (3.6)
Permanent left ventricular assist device — no./total no. (%)	1 (0.5)	1 (0.5)

ECLS-SHOCK compared early VA-ECMO vs tMCS if hemodynamic deterioration

Rescue TCS 26%

A notably high rate of prolonged cardiac arrest before inclusion

Table 1. Characteristics of the Patients at Baseline.*

Characteristic	ECLS (N = 209)	Control (N = 208)
Median age (IQR) — yr	62 (56–69)	63 (57–71)
Male sex — no. (%)	170 (81.3)	169 (81.2)
Median body-mass index (IQR)†	27 (25–30)	28 (25–31)
Signs of impaired organ perfusion — no.(%)		
Altered mental status	200 (95.7)	198 (95.2)
Cold, clammy skin and limbs	202 (96.7)	204 (98.1)
Oliguria	150 (71.8)	150 (72.1)
Median blood pressure (IQR) — mm Hg		
Systolic	95 (80–120)	97 (80–120)
Diastolic	61 (50–73)	60 (50–71)
Median heart rate (IQR) — beats/min	90 (75–110)	95 (71–110)
Resuscitation before randomization — no. (%)	162 (77.5)	162 (77.9)
Median time until return of spontaneous circulation during longest continuous resuscitation (IQR) — min	20 (10–25)	20 (12–28)

ORIGINAL ARTICLE

Intraaortic Balloon Support for Myocardial Infarction with Cardiogenic Shock

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., Marcus Hennersdorf, M.D., Klaus Empen, M.D., Georg Fuernau, M.D., Steffen Desch, M.D., Ingo Eitel, M.D., Rainer Hambrecht, M.D., Jörg Fuhrmann, M.D., Michael Böhm, M.D., Henning Ebelt, M.D., Steffen Schneider, Ph.D., Gerhard Schuler, M.D., and Karl Werdan, M.D., for the IABP-SHOCK II Trial Investigators*

Resuscitation before randomization — no./total no. (%)

IABP (N = 301)	Control (N = 299)
127 (42.2)	143 (47.8)

ORIGINAL ARTICLE

PCI Strategies in Patients with Acute Myocardial Infarction and Cardiogenic Shock

H. Thiele, I. Akin, M. Sandri, G. Fuernau, S. de Waha, R. Meyer-Saraei, P. Nordbeck, T. Geisler, U. Landmesser, C. Skurk, A. Fach, H. Lapp, J.J. Piek, M. Noc, T. Goslar, S.B. Felix, L.S. Maier, J. Stepinska, K. Oldroyd, P. Serpytis, G. Montalescot, O. Barthelemy, K. Huber, S. Windecker, S. Savonitto, P. Torremante, C. Vrints, S. Schneider, S. Desch, and U. Zeymer, for the CULPRIT-SHOCK Investigators*

Resuscitation before randomization — no./total no. (%)

Culprit-Lesion-Only PCI Group (N = 344)	Multivessel PCI Group (N = 342)
177/341 (51.9)	189/342 (55.3)

published on April 7, 2024

The NEW ENGLAND JOURNAL of MEDICINE

DOI: 10.1056/NEJMoa2312572

ORIGINAL ARTICLE

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

J.E. Møller, T. Engstrøm, L.O. Jensen, H. Eiskjær, N. Mangner, A. Polzin, P.C. Schulze, C. Skurk, P. Nordbeck, P. Clemmensen, V. Panoulas, S. Zimmer, A. Schäfer, N. Werner, M. Frydland, L. Holmvang, J. Kjærgaard, R. Sørensen, J. Lønborg, M.G. Lindholm, N.L.J. Udesen, A. Junker, H. Schmidt, C.J. Terkelsen, S. Christensen, E.H. Christiansen, A. Linke, F.J. Woitek, R. Westenfeld, S. Möbius-Winkler, K. Wachtell, H.B. Ravn, J.F. Lassen, S. Boesgaard, O. Gerke, and C. Hassager, for the DanGer Shock Investigators*

Characteristic	Microaxial Flow Pump plus Standard Care (N=179)	Standard Care Alone (N=176)
Resuscitation before randomization — no. (%)	39 (21.8)	33 (18.8)

Table 1. Characteristics of the Patients at Baseline.*

Characteristic	ECLS (N = 209)	Control (N = 208)
Diastolic	61 (50–73)	60 (50–71)
Median heart rate (IQR) — beats/min	90 (75–110)	95 (71–110)
Resuscitation before randomization — no. (%)	162 (77.5)	162 (77.9)
Median time until return of spontaneous circulation during longest continuous resuscitation (IQR) — min	20 (10–25)	20 (12–28)

Hypotension only hemodynamic variable to define CS…
What was the actual hemodynamic profile?
Low vs. N-to-High CI?

As for Septic Shock patients, ECMO can only rescue…

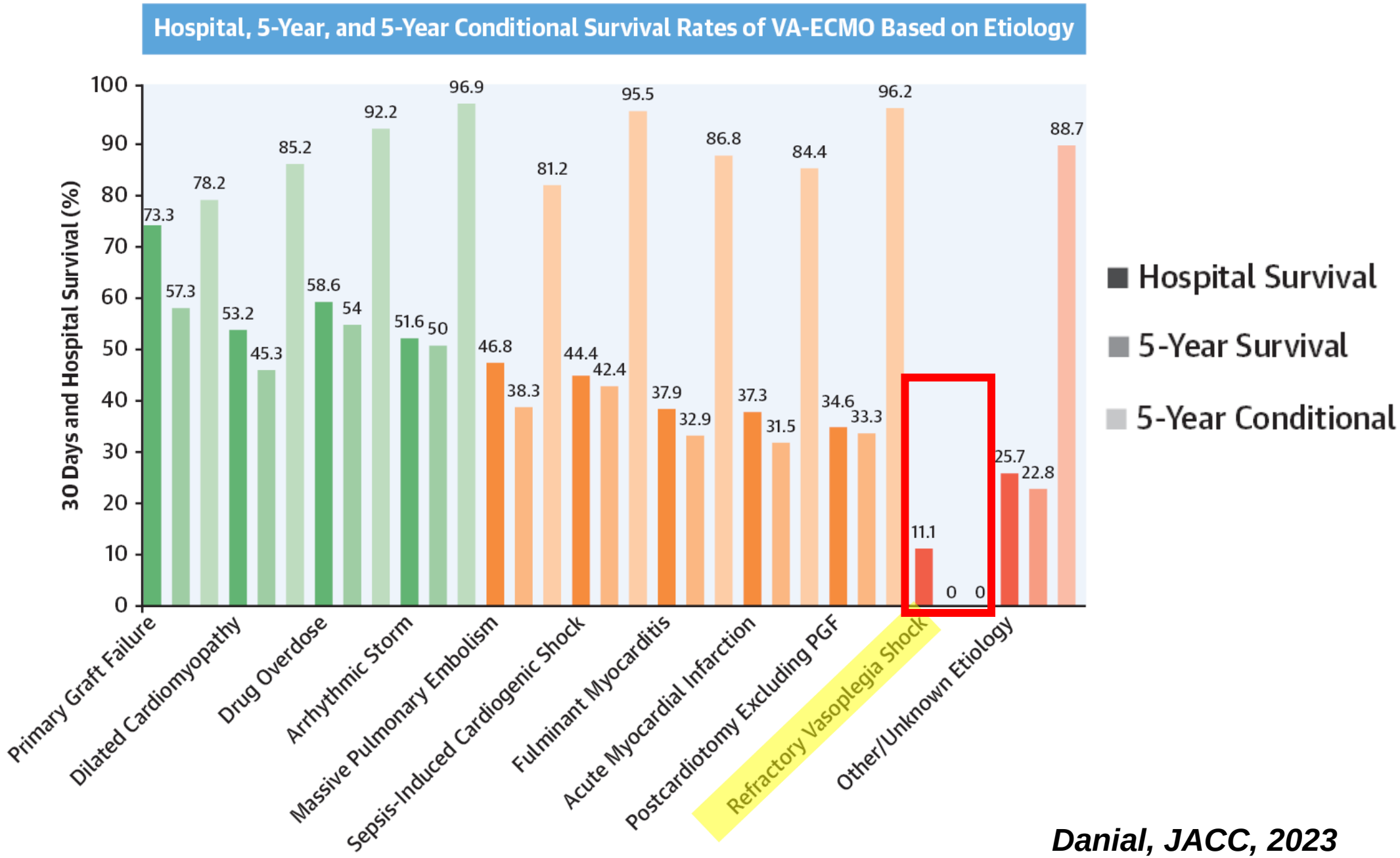
Patients with CS and low cardiac output syndrome…

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY VOL. 81, NO. 9, 2023

PUBLISHED BY ELSEVIER

Association Between Shock Etiology and 5-Year Outcomes After Venoarterial Extracorporeal Membrane Oxygenation

Pichoy Danial, MD,[a] Maud-Emmanuel Olivier, MD,[a] Nicolas Bréchot, MD, PhD,[b,c] Maharajah Ponnaiah, MD,[d] Thibaut Schoell, MD,[a] Cosimo D'Alessandro, MD,[a] Pierre Demondion, MD,[a] Marina Clément, MD,[a] Charles Juvin, MD,[a] Aude Carillion, MD, PhD,[c] Adrien Bouglé, MD, PhD,[c,d] Alain Combes, MD, PhD,[b,d] Pascal Leprince, MD, PhD,[a,c] Guillaume Lebreton, MD, PhD[a,c]



Danial, JACC, 2023

A very short duration of VA-ECMO support

Related to patients characteristics at randomization?

Characteristic	ECLS (N = 209)	Control (N = 208)
ECLS therapy — no. (%)	192 (91.9)	26 (12.5)
Initiation in catheterization laboratory		
Before revascularization	42/192 (21.9)	4/26 (15.4)
During revascularization	50/192 (26.0)	8/26 (30.8)
After revascularization	100/192 (52.1)	7/26 (26.9)
Initiation after catheterization laboratory		
<24 hr	0/192	3/26 (11.5)
≥24 hr	0/192	4/26 (15.4)
Median duration of ECLS therapy (IQR) — days	2.7 (1.5–4.8)	2.7 (2.2–3.8)
Peripheral antegrade perfusion sheath during ECLS therapy — no./total no. (%)	183/192 (95.3)	16/19 (84.2)
Median diameter of arterial cannula (IQR) — French size	17 (15–18)	17 (15–17)
Active left ventricular unloading during ECLS therapy — no./total no. (%)	11/191 (5.8)	6/19 (31.6)
Other mechanical circulatory support in patients without ECLS — no./total no. (%)	0/17	28/182 (15.4)
Intraaortic balloon pump	—	1/28 (3.6)
Impella 2.5	—	1/28 (3.6)
Impella CP	—	24/28 (85.7)
Impella 5.0	—	1/28 (3.6)
Impella 5.5	—	1/28 (3.6)
Permanent left ventricular assist device — no./total no. (%)	1 (0.5)	1 (0.5)

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY VOL. 79, NO. 13, 2022

PUBLISHED BY ELSEVIER

Mechanical Left Ventricular Unloading in Patients Undergoing Venoarterial Extracorporeal Membrane Oxygenation

E. Wilson Grandin, MD, MPH, MEd,[a,b] Jose I. Nunez, MD,[c] Brooks Willar, MD,[d] Kevin Kennedy, MS,[b] Peter Rycus, MPH,[e] Joseph E. Tonna, MD, MS,[e,f] Navin K. Kapur, MD,[g] Shahzad Shaefi, MD, MPH,[h] A. Reshad Garan, MD, MS[a]

	Total (N = 1,678)	IABP (n = 1,123)	pVAD (n = 555)	*P* Value
Time on ECMO, d	5.00 (3.00-8.00)	5.00 (3.00-8.00)	5.00 (3.00-9.00)	0.51

ORIGINAL

The ENCOURAGE mortality risk score and analysis of long-term outcomes after VA-ECMO for acute myocardial infarction with cardiogenic shock

Intensive Care Med 2016

Grégoire Muller[1], Erwan Flecher[3], Guillaume Lebreton[2], Charles-Edouard Luyt[1], Jean-Louis Trouillet[1], Nicolas Bréchot[1], Matthieu Schmidt[1], Ciro Mastroianni[2], Jean Chastre[1], Pascal Leprince[2], Amedeo Anselmi[3] and Alain Combes[1*]

Characteristic	All patients ($n = 138$)	Survivors ($n = 65$)	Non-survivors ($n = 73$)
ECMO duration, days	7 (4–10)	8 (5–12)	5 (3–9)

Characteristic	ECLS (N = 209)	Control (N = 208)
ECLS therapy — no. (%)	192 (91.9)	26 (12.5)
Initiation in catheterization laboratory		
Before revascularization	42/192 (21.9)	4/26 (15.4)
During revascularization	50/192 (26.0)	8/26 (30.8)
After revascularization	100/192 (52.1)	7/26 (26.9)
Initiation after catheterization laboratory		
<24 hr	0/192	3/26 (11.5)
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Median diameter of arterial cannula (IQR) — French size	17 (15–18)	17 (15–17)
Active left ventricular unloading during ECLS therapy — no./t… no. (%)	11/191 (5.8)	6/19 (31.6)
Other mechanical circulatory support in patients w…ut ECLS —	0/17	28/182 (15.4)

Questions about the hemodynamic phenotype of included patients, and management of VA-ECMO weaning

A notably low rate of LV unloading…

Related to patients characteristics at randomization?

	ECLS (n=209)	Control (n=208)
Active left ventricular unloading during ECLS therapy; n/total (%)	11/190 (5.8)	6/19 (31.6)
Reason for unloading*; n/total (%)		
No arterial waveform pulsatility	4/11 (36.4)	3/6 (50.0)
No aortic valve opening assessed by echocardiography	0/11	0/6
Velocity time interval <10 cm over left ventricular outflow tract	2/11 (18.2)	0/6
Increase in diameters and volume of the left ventricle assessed by echocardiography	2/11 (18.2)	1/6 (16.7)
Prophylactic/routine use	4/11 (36.4)	3/6 (50.0)

	ECLS (n=209)	Control (n=208)
Type of unloading; n/total (%)		
Additional insertion of IABP	2/11 (18.2)	2/6 (33.3)
Additional insertion of percutaneous left ventricular assist device (Impella®)	9/11 (81.8)	4/6 (66.7)
Atrial septostomy with drainage of the left atrium by a pigtail catheter connected to the venous cannula of the ECLS	0/11	0/6
Pulmonary artery drainage with connection to the venous cannula of the ECLS	0/11	0/6
Transaortic venting by pigtail catheter insertion into the left ventricle and connection to the venous cannula of the ECLS	0/11	0/6

Mechanical Left Ventricular Unloading in Patients Undergoing Venoarterial Extracorporeal Membrane Oxygenation

E. Wilson Grandin, MD, MPH, MED,[a,b] Jose I. Nunez, MD,[c] Brooks Willar, MD,[d] Kevin Kennedy, MS,[b] Peter Rycus, MPH,[e] Joseph E. Tonna, MD, MS,[e,f] Navin K. Kapur, MD,[g] Shahzad Shaefi, MD, MPH,[h] A. Reshad Garan, MD, MS[a]

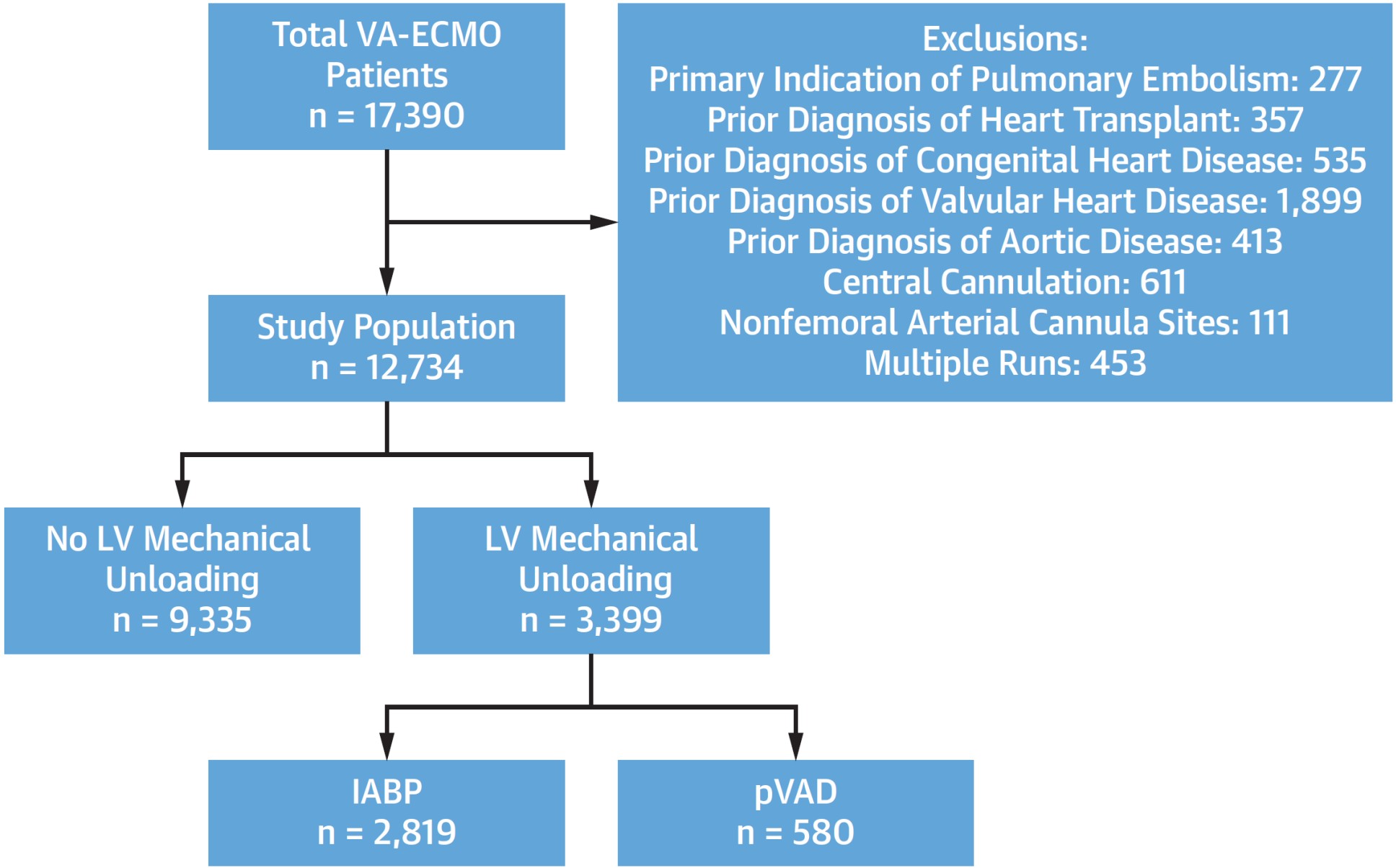
JACC VOL. 79, NO. 13, 2022
APRIL 5, 2022:1239–1250

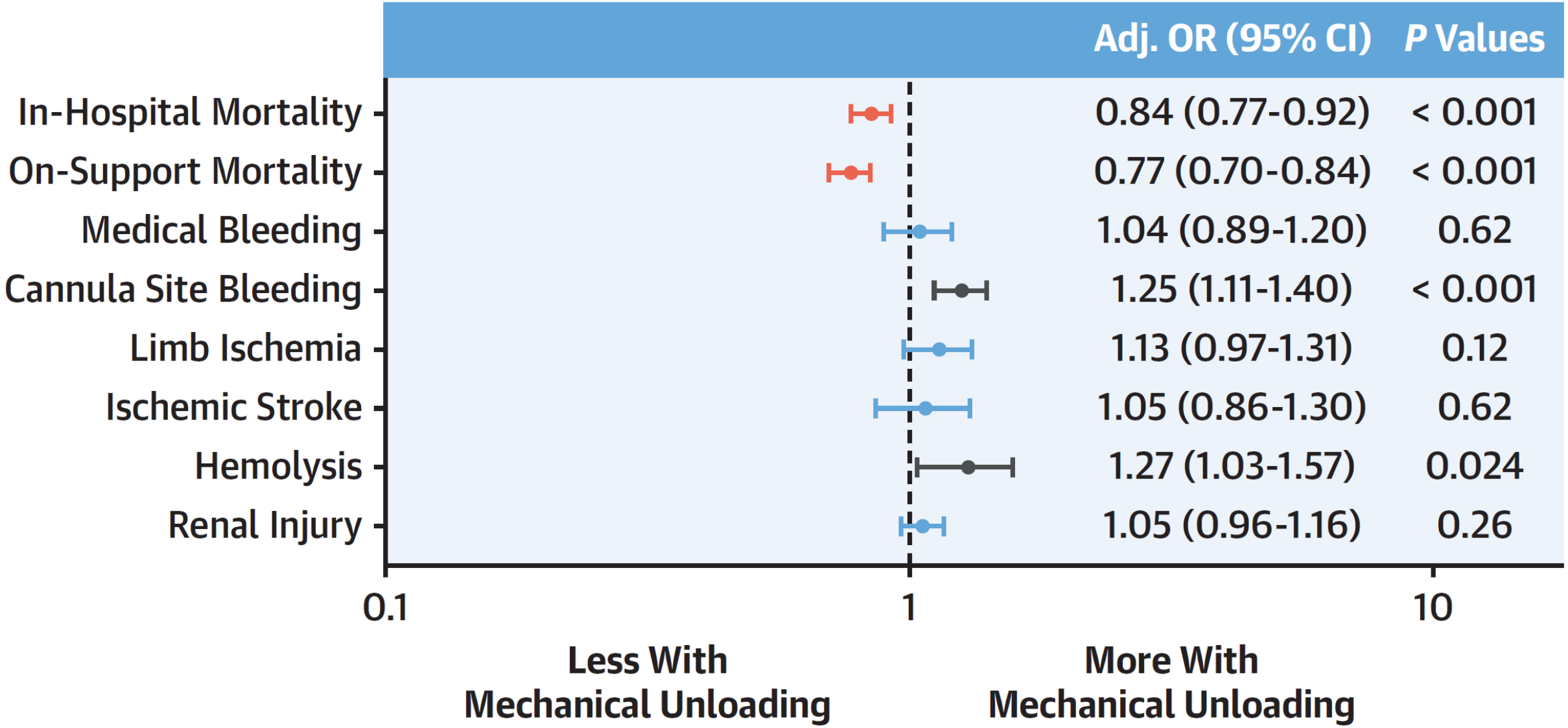
ABSTRACT

BACKGROUND Venoarterial extracorporeal membrane oxygenation (VA-ECMO) increases left ventricular (LV) afterload, potentially provoking LV distention and impairing recovery. LV mechanical unloading (MU) with intra-aortic balloon pump (IABP) or percutaneous ventricular assist device (pVAD) can prevent LV distension, potentially at the risk of more complications, and net clinical benefit remains uncertain.

OBJECTIVES This study aims to determine the association between MU and outcomes for patients undergoing VA-ECMO.

METHODS The authors queried the Extracorporeal Life Support Organization registry for adults receiving peripheral VA-ECMO from 2010 to 2019 and stratified them by MU with IABP or pVAD. The primary outcome was in-hospital mortality; secondary outcomes included on-support mortality and complications during VA-ECMO.


Total VA-ECMO Patients
n = 17,390
Exclusions:
Primary Indication of Pulmonary Embolism: 277
Prior Diagnosis of Heart Transplant: 357
Prior Diagnosis of Congenital Heart Disease: 535
Prior Diagnosis of Valvular Heart Disease: 1,899
Prior Diagnosis of Aortic Disease: 413
Central Cannulation: 611
Nonfemoral Arterial Cannula Sites: 111
Multiple Runs: 453
Study Population
n = 12,734
No LV Mechanical Unloading
n = 9,335
LV Mechanical Unloading
n = 3,399
IABP
n = 2,819
pVAD
n = 580


Adj. OR (95% CI)
P Values
In-Hospital Mortality
0.84 (0.77-0.92)
< 0.001
On-Support Mortality
0.77 (0.70-0.84)
< 0.001
Medical Bleeding
1.04 (0.89-1.20)
0.62
Cannula Site Bleeding
1.25 (1.11-1.40)
< 0.001
Limb Ischemia
1.13 (0.97-1.31)
0.12
Ischemic Stroke
1.05 (0.86-1.30)
0.62
Hemolysis
1.27 (1.03-1.57)
0.024
Renal Injury
1.05 (0.96-1.16)
0.26
0.1
1
10
Less With Mechanical Unloading
More With Mechanical Unloading

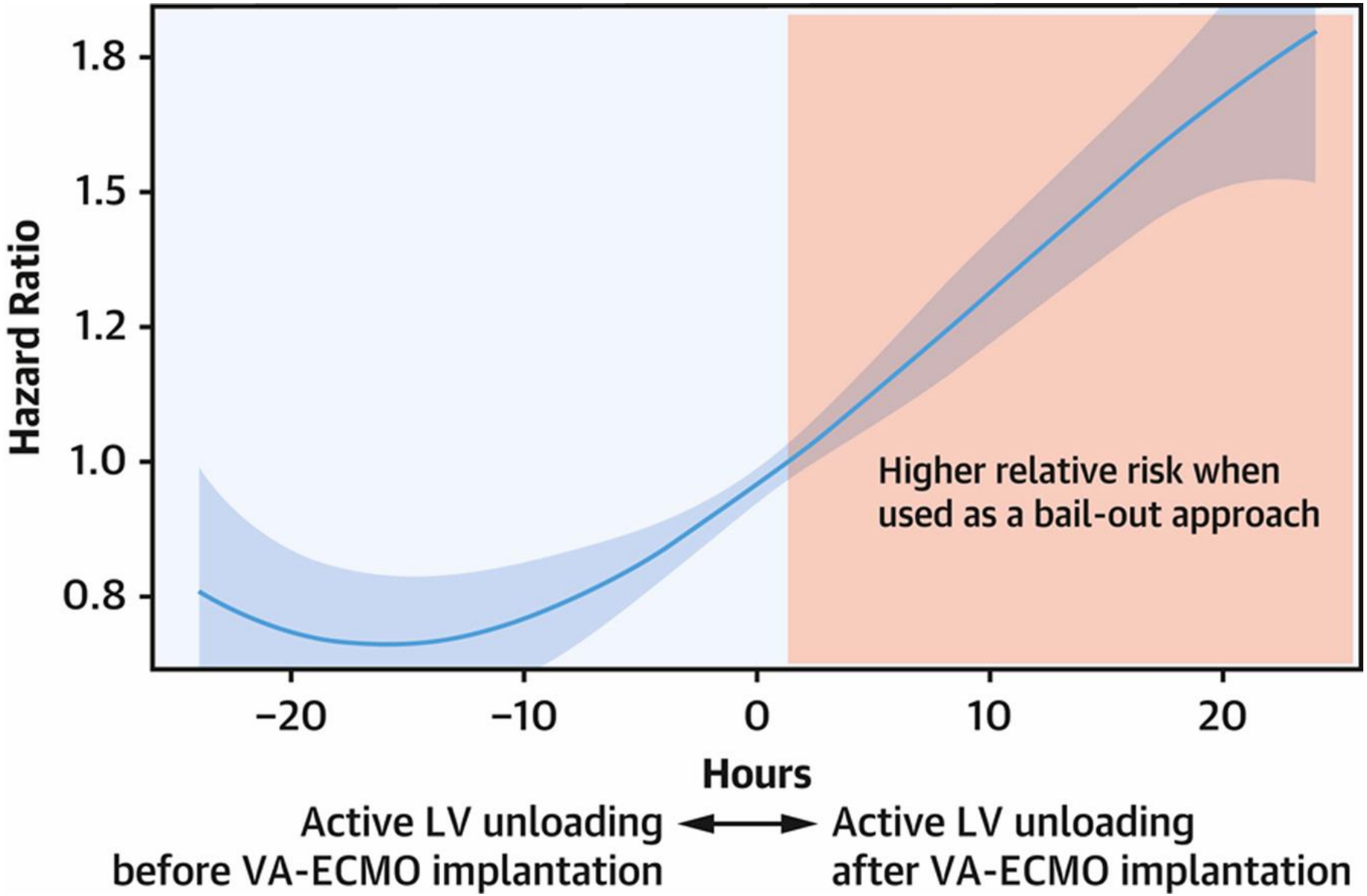
JACC: Heart Failure

Timing of Active Left Ventricular Unloading in Patients on Venoarterial Extracorporeal Membrane Oxygenation Therapy

Original Research Paper

Benedikt Schrage, Jonas Sundermeyer, Stefan Blankenberg, Pascal Colson, Dennis Eckner, Matthias Eden, Ingo Eitel, Derk Frank, Norbert Frey, Tobias Graf, Paulus Kirchhof, Danny Kupka, ... SEE ALL AUTHORS

421 CS patients VA-ECMO and active LV unloading
Early vs delayed active LV unloading defined by implantation before up to 2 hours after VA-ECMO


1.8
1.5
1.2
1.0
0.8
Hazard Ratio
Higher relative risk when
used as a bail-out approach
−20
−10
0
10
20
Hours
Active LV unloading
before VA-ECMO implantation
Active LV unloading
after VA-ECMO implantation

A surprising high rate of death related to refractory CS…

	ECLS (n=209)	Control (n=208)
All-cause mortality at 30 days; n/total (%)	100/209 (47.8)	102/208 (49.0)
Causes of death at 30 days		
Refractory cardiogenic shock, n/total (%)	51/100 (51.0)	56/102 (54.9)
Sudden cardiac death; n/total (%)	7/100 (7.0)	5/102 (4.9)
Recurrent myocardial infarction; n/tot	2/100 (2.0)	2/102 (2.0)
Mechanical complication of infarction; n/total (%)	1/100 (1.0)	1/102 (1.0)
	4/100 (4	
	26/100 (2	
	4/100 (4	
Unknown cause; n/total (%)	0/100	
Other cause; n/total (%)	5/100 (5.0)	0/102

Questions about the hemodynamic phenotype of included patients, and management of VA-ECMO weaning

Questions about underutilization of t-MCS in Control patients

A surprising low rate of LVAD for non-recovering LV dysfunction…

Characteristic	ECLS (N = 209)	Control (N = 208)
ECLS therapy — no. (%)	192 (91.9)	26 (12.5)
Initiation in catheterization laboratory		
Before revascularization	42/192 (21.9)	4/26 (15.4)
During revascularization	50/192 (26.0)	8/26 (30.8)
After revascularization	100/192 (52.1)	7/26 (26.9)
Initiation after catheterization laboratory		
<24 hr	0/192	3/26 (11.5)
≥24 hr	0/192	4/26 (15.4)
Median duration of ECLS therapy (IQR) — days	2.7 (1.5–4.8)	2.7 (2.2–3.8)
Peripheral antegrade perfusion sheath during ECLS therapy — no./total no. (%)	183/192 (95.3)	16/19 (84.2)
Median diameter of arterial cannula (IQR) — French size	17 (15–18)	17 (15–17)
Active left ventricular unloading during ECLS therapy — no./total no. (%)	11/191 (5.8)	6/19 (31.6)
Other mechanical circulatory support in patients without ECLS — no./total no. (%)	0/17	28/182 (15.4)
Intraaortic balloon pump	—	1/28 (3.6)
Impella 2.5	—	1/28 (3.6)
Impella CP	—	24/28 (85.7)
Impella 5.0	—	1/28 (3.6)
Impella 5.5	—	1/28 (3.6)
Permanent left ventricular assist device — no./total no. (%)	1 (0.5)	1 (0.5)

ORIGINAL ARTICLE

N Engl J Med 2012.

Intraaortic Balloon Support for Myocardial Infarction with Cardiogenic Shock

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., Marcus Hennersdorf, M.D., Klaus Empen, M.D., Georg Fuernau, M.D., Steffen Desch, M.D., Ingo Eitel, M.D., Rainer Hambrecht, M.D., Jörg Fuhrmann, M.D., Michael Böhm, M.D., Henning Ebelt, M.D., Steffen Schneider, Ph.D., Gerhard Schuler, M.D., and Karl Werdan, M.D., for the IABP-SHOCK II Trial Investigators*

33 patients (5.5%) had a VAD at Day 30
Mortality higher than for other patients
69.7% vs. 38.8%, P<0.001

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

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

J.E. Møller, T. Engstrøm, L.O. Jensen, H. Eiskjær, N. Mangner, A. Polzin, P.C. Schulze, C. Skurk, P. Nordbeck, P. Clemmensen, V. Panoulas, S. Zimmer, A. Schäfer, N. Werner, M. Frydland, L. Holmvang, J. Kjærgaard, R. Sørensen, J. Lønborg, M.G. Lindholm, N.L.J. Udesen, A. Junker, H. Schmidt, C.J. Terkelsen, S. Christensen, E.H. Christiansen, A. Linke, F.J. Woitek, R. Westenfeld, S. Möbius-Winkler, K. Wachtell, H.B. Ravn, J.F. Lassen, S. Boesgaard, O. Gerke, and C. Hassager, for the DanGer Shock Investigators*

published on April 7, 2024

DOI: 10.1056/NEJMoa2312572

Management	Microaxial Flow Pump plus Standard Care (N=179)	Standard Care Alone (N=176)
Escalation to additional mechanical circulatory support		
Placement of Impella 5.0 device — no. (%)	7 (3.9)	5 (2.8)
Placement of Impella CP for venting during venoarterial ECMO therapy — no. (%)	0	4 (2.3)
Placement of Impella 2.5 device — no. (%)	0	1 (0.6)
Placement of Impella RP device — no. (%)	0	0
Venoarterial ECMO — no. (%)	21 (11.7)	33 (18.8)
Median time from randomization to placement of venoarterial ECMO (IQR) — hr	14 (4–54)	2 (1–5)
Placement of permanent LVAD — no. (%)	10 (5.6)	4 (2.3)
Any escalation to additional mechanical circulatory support — no. (%)	28 (15.6)§	37 (21.0)¶

Letters

JACC, 2020

Extracorporeal Membrane Oxygenation in Myocardial Infarction Complicated by Cardiogenic Shock

Analysis of the ELSO Registry

TABLE 1 Patient Characteristics and Complications

	MI (n = 756)	No MI (n = 5,890)	p Value
Baseline characteristics			
Age, yrs	59.17 ± 10.42	54.4 ± 14.49	<0.01
Male	597 (79.6)	3,940 (68.0)	<0.01
Baseline pH	7.22 ± 0.18	7.25 ± 0.17	<0.01
Baseline SBP, mm Hg	81.8 ± 30.4	84.3 ± 27.8	0.05
Baseline CI, l/min/m^2	1.81 ± 0.61	1.96 ± 0.73	0.015
Per-ECLS arrest			<0.01
Yes	429 (58.2)	2,488 (43.3)	
No	308 (41.8)	3,252 (56.7)	

Ventricular assist device (VAD)
or Heart transplant
in 5% of the patients

ORIGINAL

The ENCOURAGE mortality risk score and analysis of long-term outcomes after VA-ECMO for acute myocardial infarction with cardiogenic shock

Intensive Care Med 2016

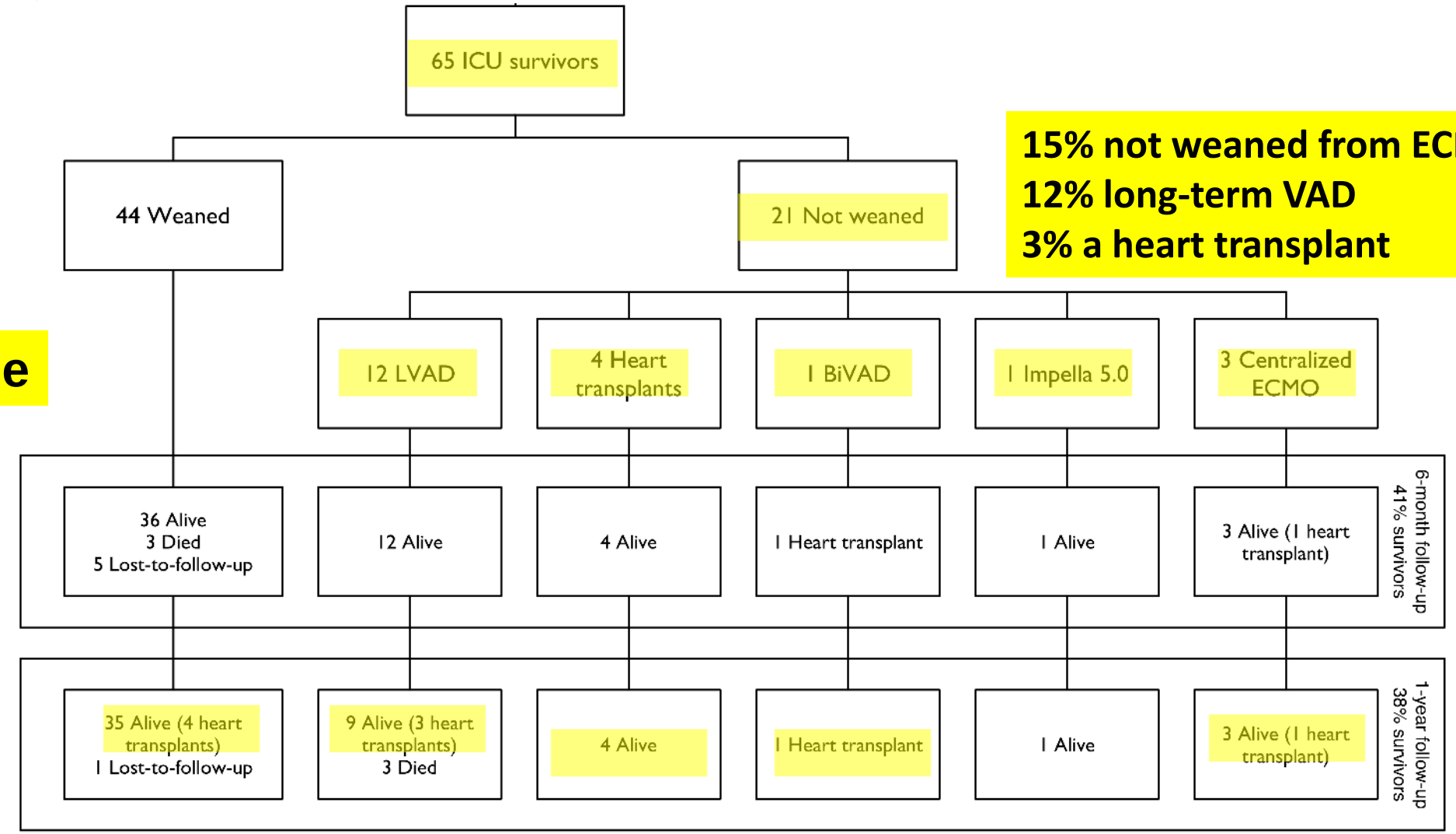
138 AMICS on VA-ECMO for refractory shock

15% not weaned from ECMO
12% long-term VAD
3% a heart transplant

ICU discharge

6 Months

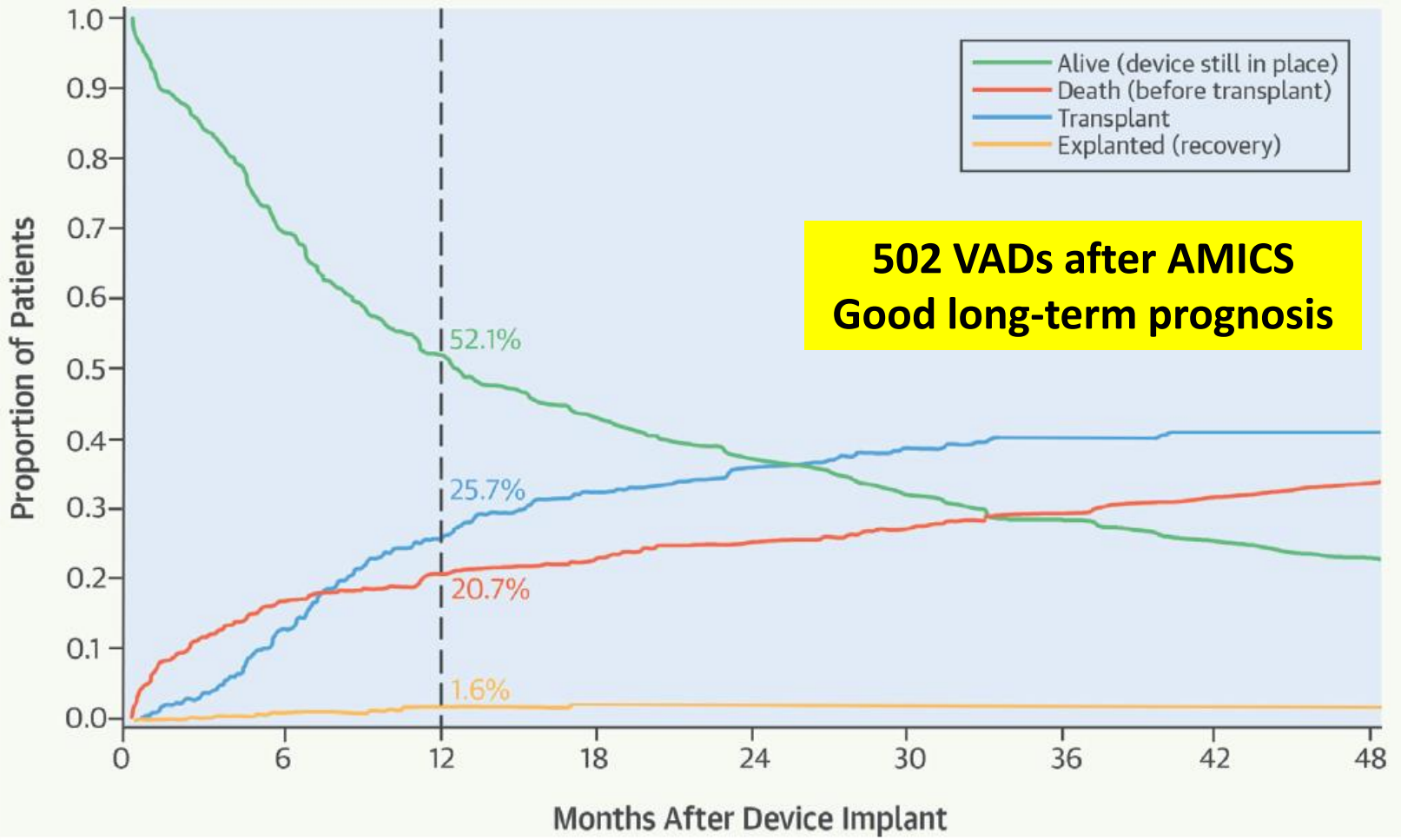
12 Months



Ventricular Assist Device in Acute Myocardial Infarction

JACC, 2016

Deepak Acharya, MD, MSPH,[a] Renzo Y. Loyaga-Rendon, MD, PhD,[a] Salpy V. Pamboukian, MD, MSPH,[a]
José A. Tallaj, MD,[a] William L. Holman, MD,[b] Ryan S. Cantor, MSPH,[b,c] David C. Naftel, PhD,[b] James K. Kirklin, MD[b]

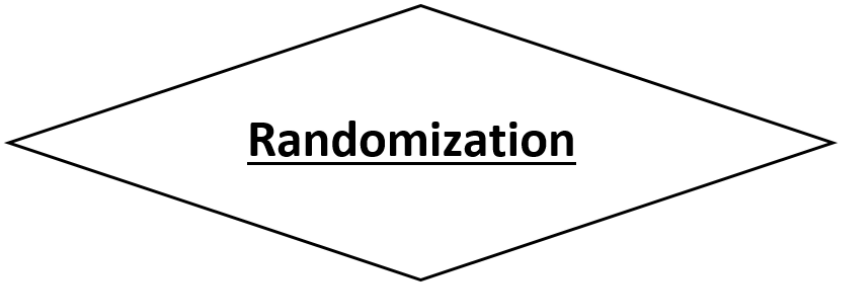


502 VADs after AMICS
Good long-term prognosis

Assessment of ECMO in acute myocardial infarction with Non-reversible Cardiogenic shock to Halt Organ failure and Reduce mortality

The ANCHOR trial

NCT04184635



Experimental Treatment Arm

– Protocolized conventional management of cardiogenic shock
– VA-ECMO will be started as rapidly as possible
– For patients randomized at non-ECMO centers, a mobile ECMO team will initiate ECMO at the non-ECMO center and transport the patient to the ECMO center immediately
– IABP inserted in the contralateral femoral artery (unless technically not possible)
– ECMO management according to protocol
– ECMO weaning according to protocol

Control Conventional Treatment Arm

– Protocolized conventional management of cardiogenic shock
– IABP not recommended. No other mechanical device (e.g., Impella, Thoratec PHP, TandemHeart) permitted
– Rescue VA-ECMO if one of 1 or 2 or 3:
- 1 Refractory cardiogenic shock defined as
    a. Cardiac index <1.2 l/min/m² or VTI <6 cm AND
    b. Assessment and correction of hypovolemia AND
    c. (dobutamine ≥15 microg/kg/min + norepinephrine ≥1.5 microg/kg/min) OR epinephrine ≥ 0.75 microg/kg/min
    d. Serum lactate >5 mmol/L or serum lactate increased >50% in the last 6 hours
- 2 Uncontrolled lethal arrhythmia K >4.5 mmol/l AND Mg >1.0 mmol/l AND Intubation and mechanical ventilation with deep sedation AND IV Loading of amiodarone AND IV xylocaine
- 3 Refractory cardiac arrest
PLUS Mandatory validation by an independent adjudicator

Challenges of tCS RCTs

Intensive Care Med
https://doi.org/10.1007/s00134-024-07356-0

WHAT'S NEW IN INTENSIVE CARE

What's new in VA-ECMO for acute myocardial infarction-related cardiogenic shock

Alain Combes[1,2*], Susanna Price[3,4] and Bruno Levy[5]

Adequate ECMO indications

- SCAI SHOCK D-E patients
- Low cardiac output: CI < 1,8-2 L/min/m²
- Lactate >3 or Increasing lactate
- Increasing inotropes/vasopressors

RCTs are needed

- Indication biases in retrospective series
- No high quality evidence

Potential benefits of ECMO

- Halts the vicious circle of end-organ hypoperfusion
- Bridge to LV recovery post AMI LV sideration
- Bridge to VAD/Htx for non-recovering patients

ECMO FOR AMICS

ECMO NON-indications

- SCAI SHOCK C patients
- CI > 2-2,2 L/min/m²
- Advanced age/comorbidities
- Prolonged cardiac arrest
- Advanced multiple organ failure

Challenges of RCTs

- Short time window for enrolment, hard to obtain consent before randomization
- Lack of equipoise? High rate of cross-over to ECMO
- Frequently underpowered
- Protocolized management difficult
- ECMO/postECMO competing risk of mortality

ECMO-associated complications

- Severe bleeding and/or thrombosis
- Thrombocytopenia, hemolysis
- Limb ischemia
- LV dilation / Pulmonary edema
- Infection / Sepsis
- Drug sequestration

Optimized Management under ECMO

- Management in an experienced ECMO center
- LV unloading in most patients
- Leg distal perfusion of the superficial femoral artery
- Anticoagulation
- No intubation/Early Extubation

Optimized Management after ECMO

- Protocolized weaning
- Femoral artery closing device
- Heart failure clinic for optimized treatment
- Long-term VAD or heart transplantation for non-recovering LV

Combes et al, Intensive Care Med, 2024

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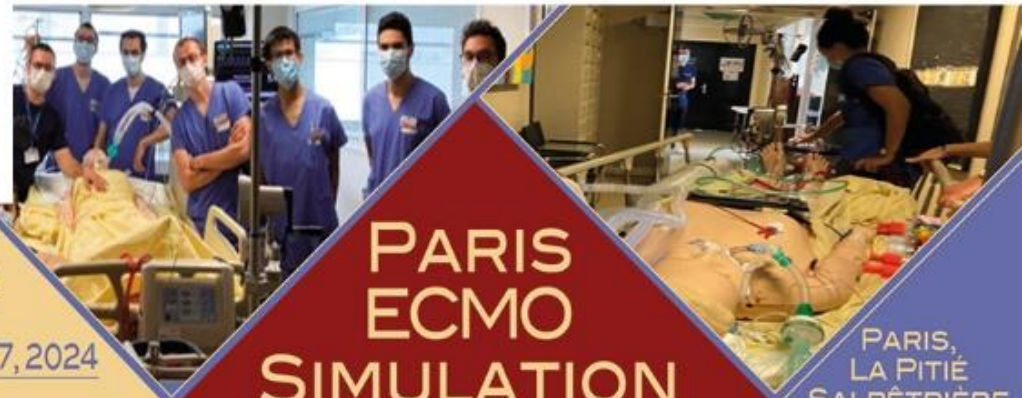

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