PLACE

PLATFORM OF LABORATORIES FOR ADVANCES IN CARDIAC EXPERIENCE

ROMA
Centro Congressi
di Confindustria
Auditorium
della Tecnica

9ª Edizione

30 Settembre
1 Ottobre
2022

SCOMPENSO ACUTO e SHOCK CARDIOGENO

SHOCK NELLE SINDROMI CORONARICHE ACUTE

Luisa Cacciavillani

Epidemiology and prognosis of infarct-related CS

- THE INCIDENCE OF CS IS APPROXIMATELY 5–10% IN STEMI AND 2–4% in NSTEMI
- MORTALITY OF CS IS HIGHT, ROUGHLY HALF OF PATIENTS DO NOT SURVIVE UNTIL HOSPITAL DISCHARGE OR 30-DAY FOLLOW-UP

European Heart Journal: Acute Cardiovascular Care 2020, Vol. 9(2) 183–197

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Definition of infarct-related cardiogenic shock

THE CLINICAL DEFINITION OF CS INCLUDES POOR CARDIAC OUTPUT AND EVIDENCE OF TISSUE HYPOXIA IN THE PRESENCE OF ADEQUATE INTRAVASCULAR VOLUME

Hypotension >30 min (a)	Evidence (clinical symptoms and/or signs) of:	
	Tissue hypo-perfusion with at least one of the following criteria (b):	Elevated left ventricular filling pressures (c)
Systolic blood pressure <90 mm Hg for >30 min or need of vasopressors to maintain pressure >90 mm Hg during systole	1. Altered mental status 2. Cold, clammy skin and extremities 3. Oliguria with urine output <30 ml/h 4. Arterial lactate >2.0 mmol/l	Pulmonary congestion confirmed by: Clinical examination (new orthopnoea) or chest radiography Pulmonary capillary wedge pressure derived from: • Pulmonary artery catheterization or • By Doppler echocardiography (mitral E wave deceleration time ≤130 ms)

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Cause of infarct-related cardiogenic shock

- LEFT VENTRICULAR PUMP FAILURE - FE<40%
- SHOCK SECONDARY TO MECHANICAL CAUSES: ACUTE MITRAL REGURGITATION, RUPTURE OF THE VENTRICULAR SEPTUM OR FREE WALL
- SHOCK SECONDARY TO PREDOMINANT RIGHT VENTRICULAR FAILURE

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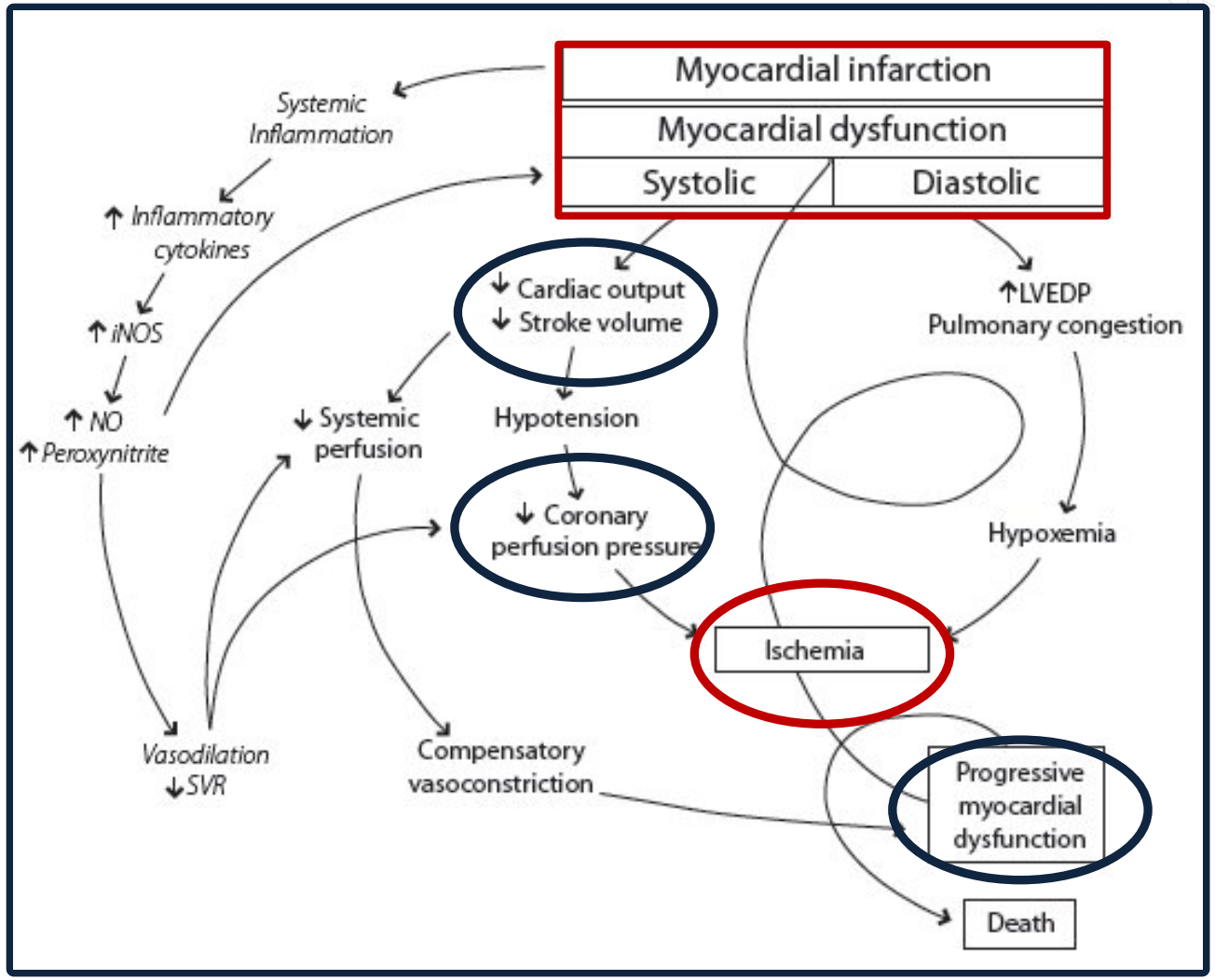
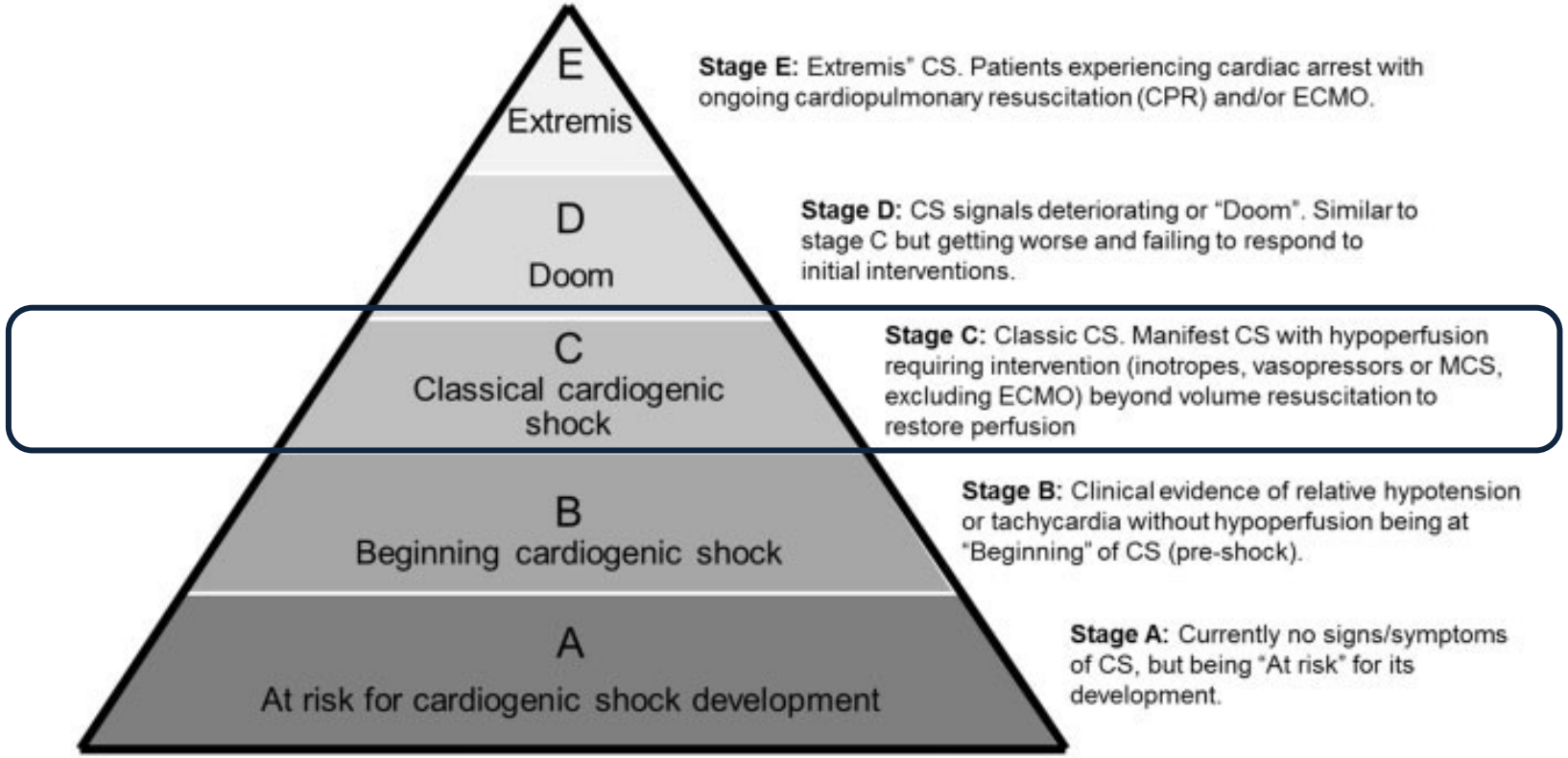
PATHOPHYSIOLOGY OF CARDIOGENIC SHOCK

Cardiac function is further impaired due to the additional decrease in coronary perfusion, worsening myocardial ischaemia, further impairment in LV diastolic and systolic function.



Circulation. 2003;107:2998-3002

CARDIOGENIC SHOCK PYRAMID



European Heart Journal (2019) 40, 2671–2683

Management of cardiogenic shock complicating

update 2019

nne de Waha-Thiele[4], Uwe Zeymer[5],

Position paper

Acute Cardiovascular Care Association position statement for the diagnosis and treatment of patients with acute infarction complicated shock: A Cardiova the Euro

2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure

d treatment of acute
of Cardiology (ESC)

2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation

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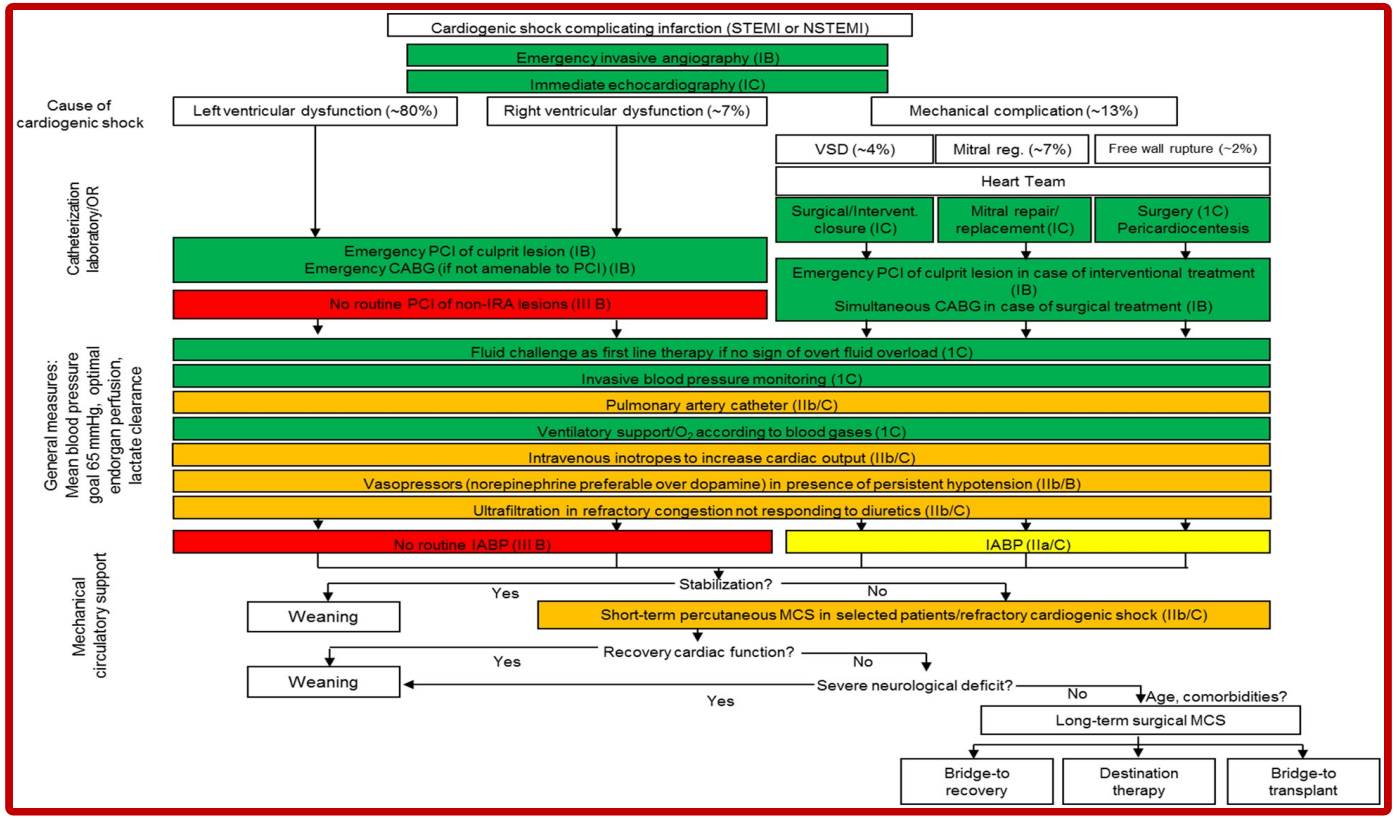
PLATFORM OF LABORATORIES FOR ADVANCES IN CARDIAC EXPERIENCE

Treatment algorithm for cardiogenic shock complicating myocardial infarction



ESC European Society of Cardiology

European Heart Journal (2019) 40, 2671–2683

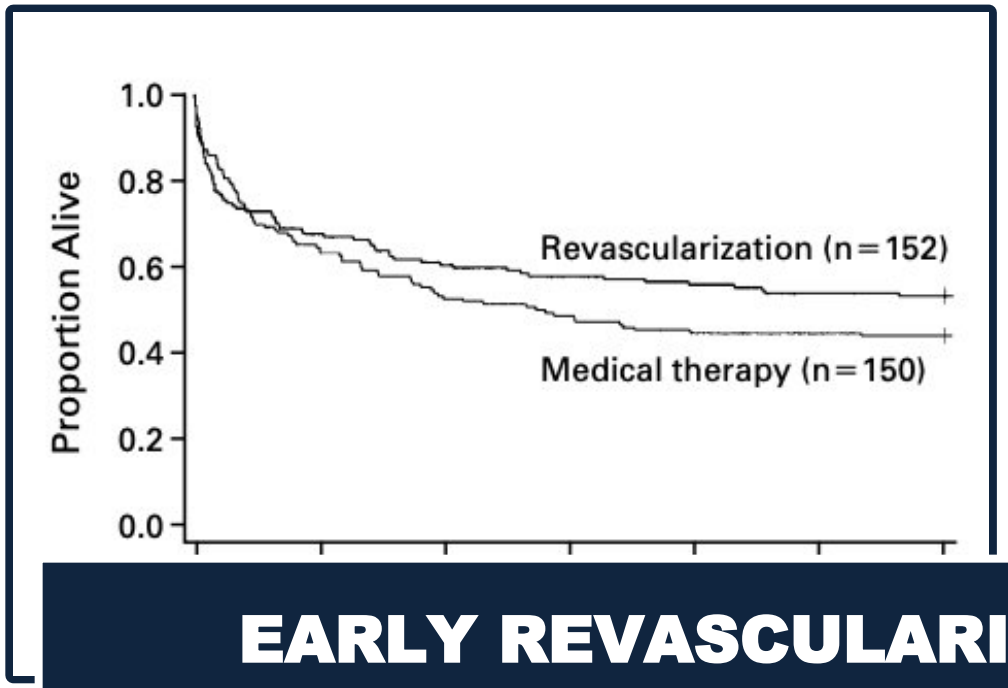
Treatment algorithm for cardiogenic shock complicating myocardial infarction

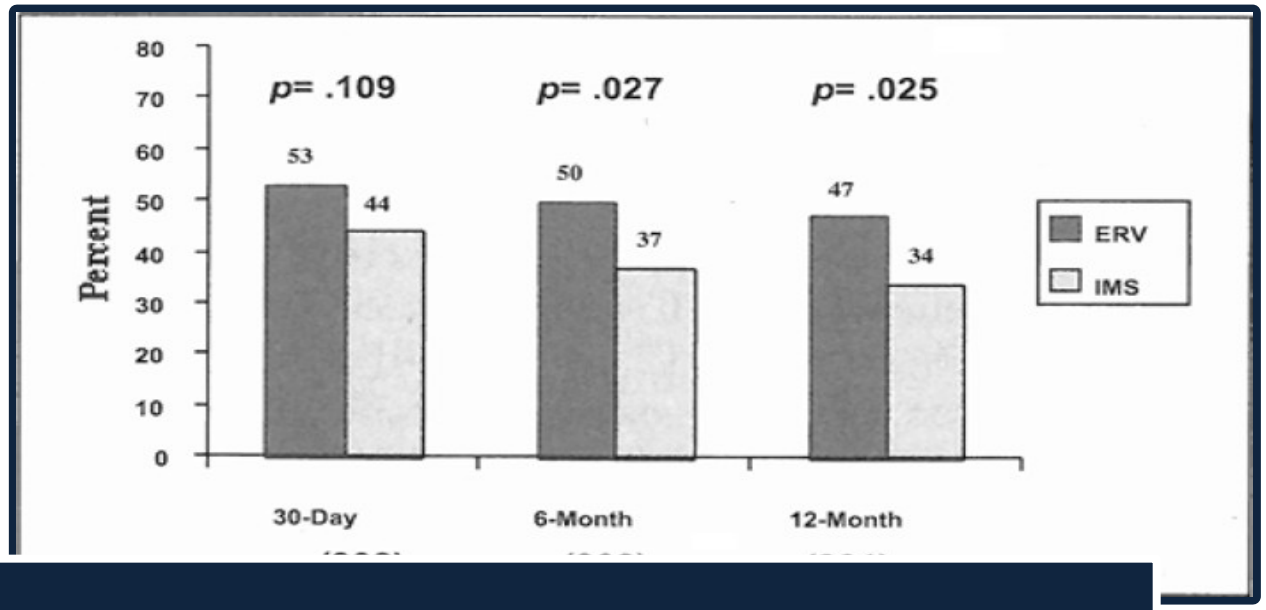
CORONARY REPERFUSION IS THE MAINSTAY EVIDENCE-BASED THERAPEUTIC INTERVENTION FOR PATIENTS WITH ACUTE MI PRESENTING WITH CS.

European Heart Journal (2019) 40, 2671–2683

Early Revascularization in Acute Myocardial Infarction Complicated by Cardiogenic Shock

SHOCK TRIAL SURVIVAL AT 1, 6, 12 MONTHS



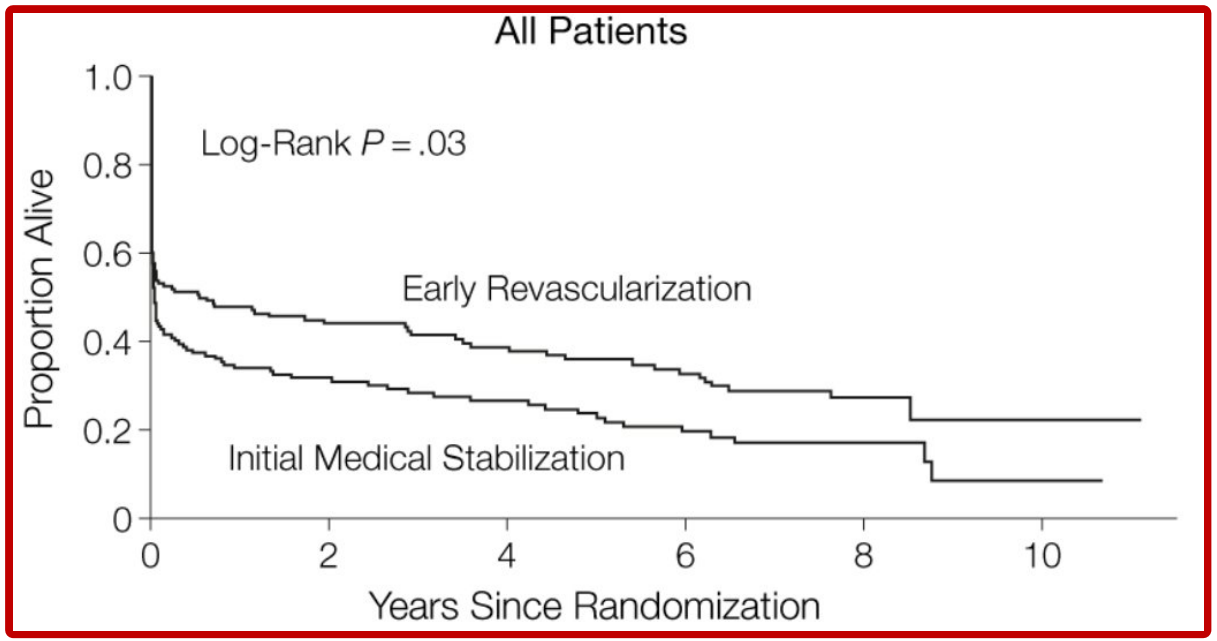


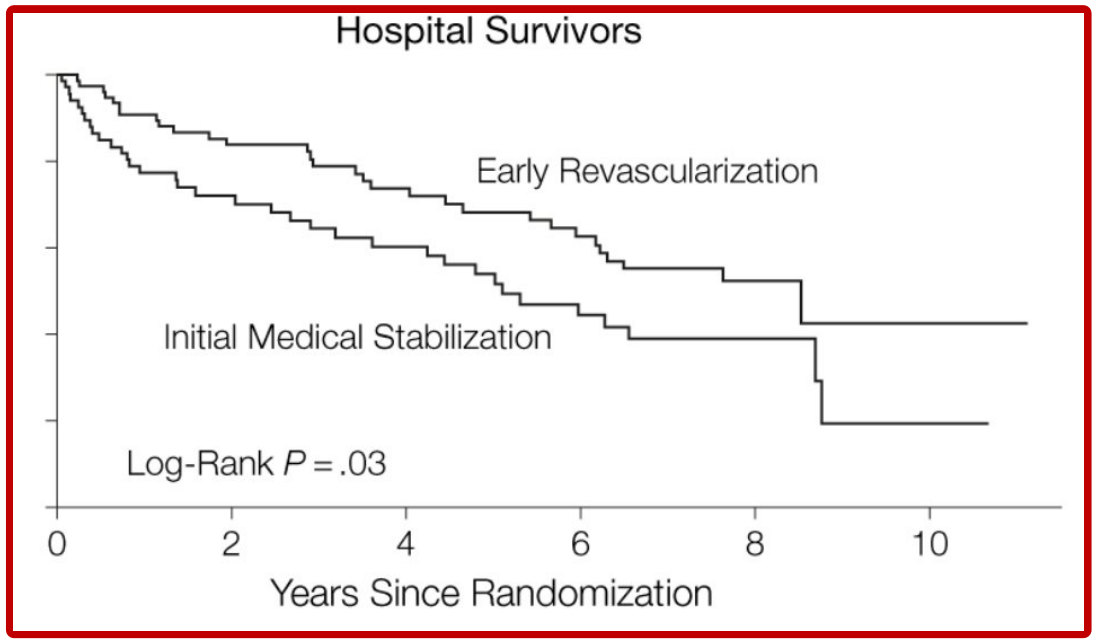
EARLY REVASCULARIZATION STRATEGY IMPROVED SURVIVAL COMPARED TO INITIAL INTENSIVE MEDICAL

N Engl J Med 1999;341:625-34

CHF 2003;9:35-39,46

Early Revascularization Improves Long-Term Survival for Cardiogenic Shock Complicating Acute Myocardial Infarction



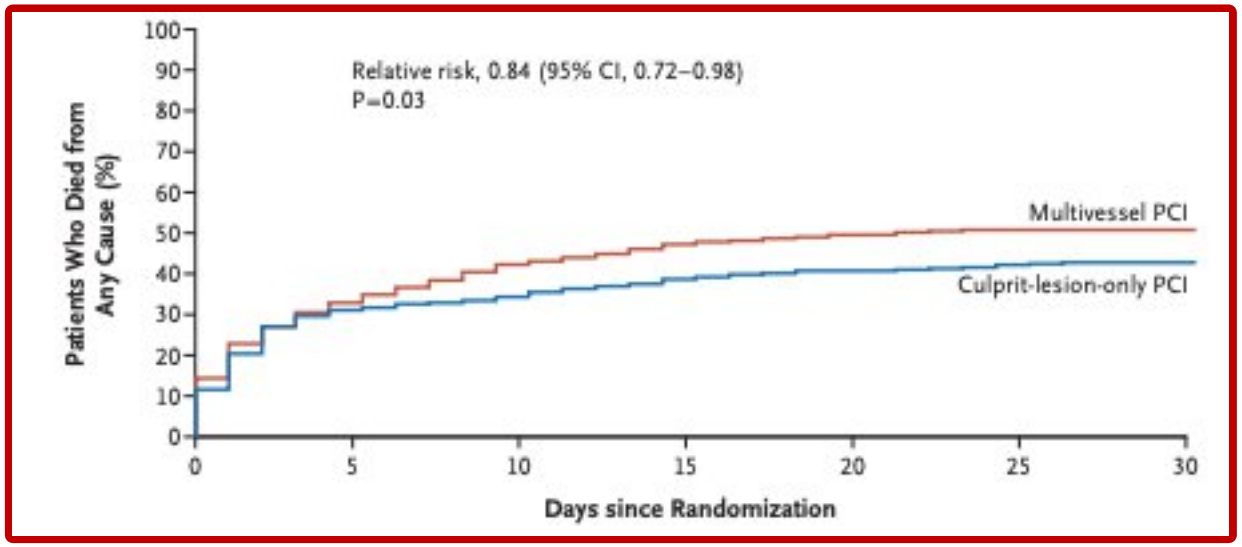


EARLY REVASCULARIZATION STRATEGY IMPROVED SURVIVAL COMPARED TO INITIAL INTENSIVE MEDICAL

JAMA. 2006, 7; 295(21): 2511–2515

PCI Strategies in Patients with Acute Myocardial Infarction and Cardiogenic Shock

In CULPRIT TRIAL the risk of a composite of death or renal-replacement therapy was lower among those who initially underwent PCI of the culprit lesion only

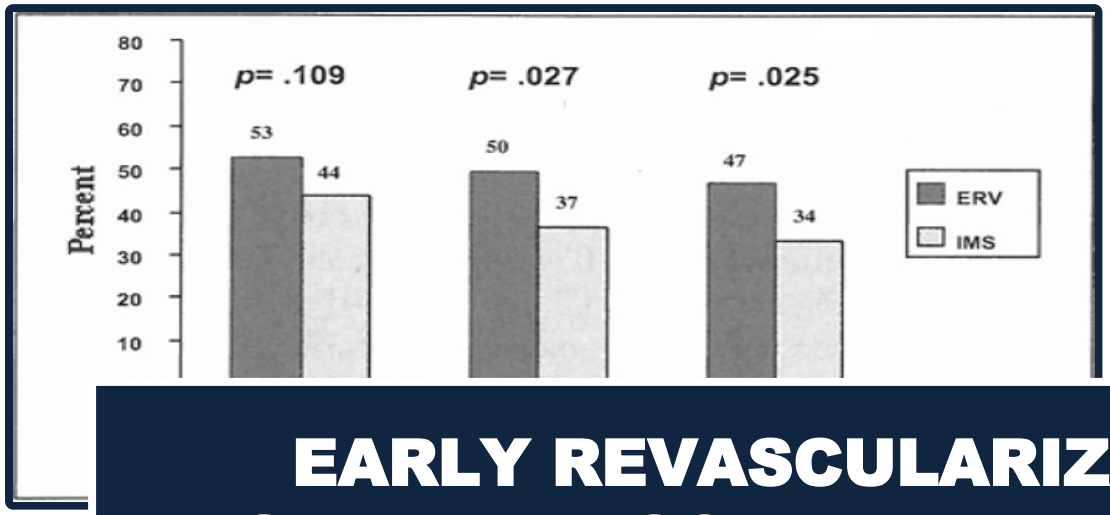


THIS OUTCOME WAS MAINLY DRIVEN BY LOWER MORTALITY AMONG PTS WHO UNDERWENT CULPRIT-LESION-ONLY PCI.

N Engl J Med 2017; 377:2419-243

SHOCK TRIAL

Early Revascularization in Acute Myocardial Infarction Complicated by Cardiogenic Shock



CULPRIT TRIAL

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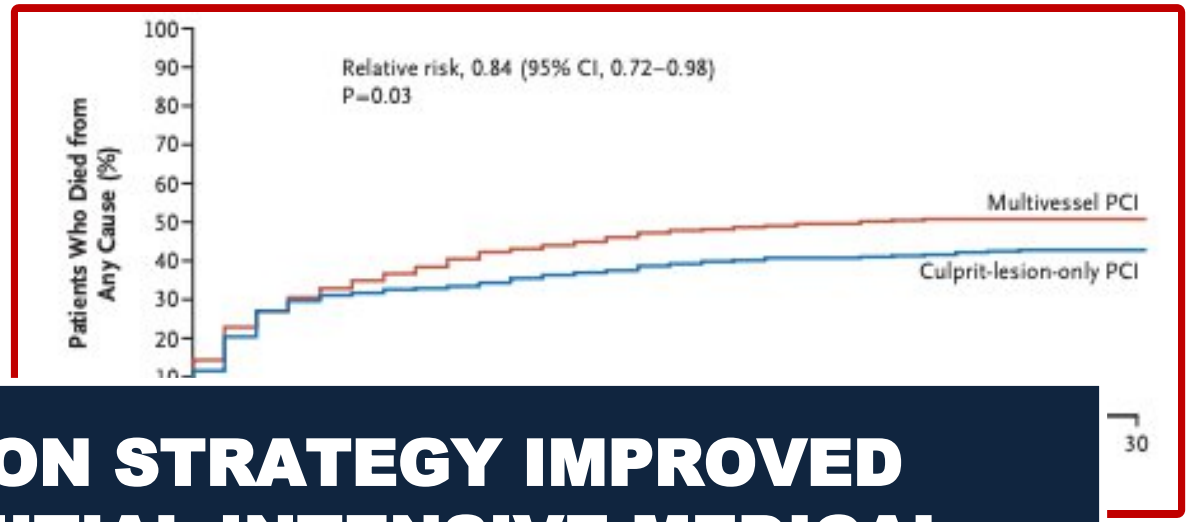

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CULPRIT-LESION-ONLY PCI IMPROVED SURVIVAL COMPARED TO ROUTINE IMMEDIATE MULTIVESSEL PCI

N Engl J Med 1999;341:625-34

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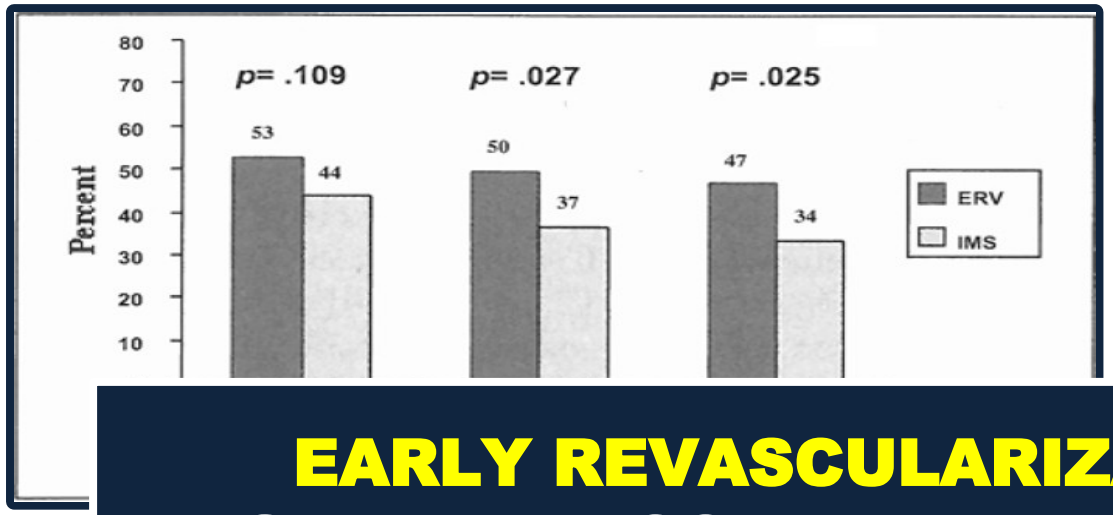

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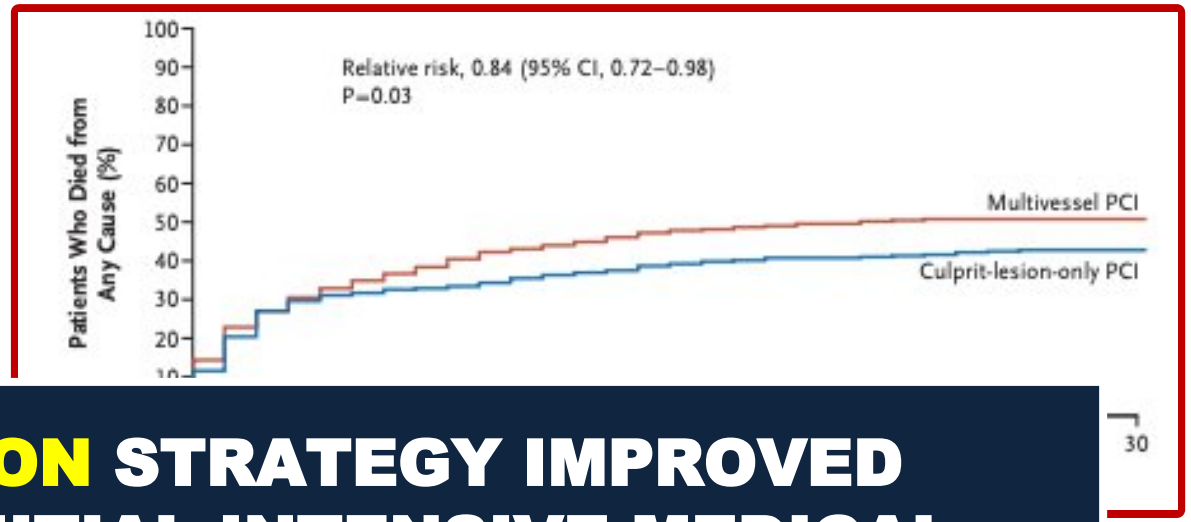

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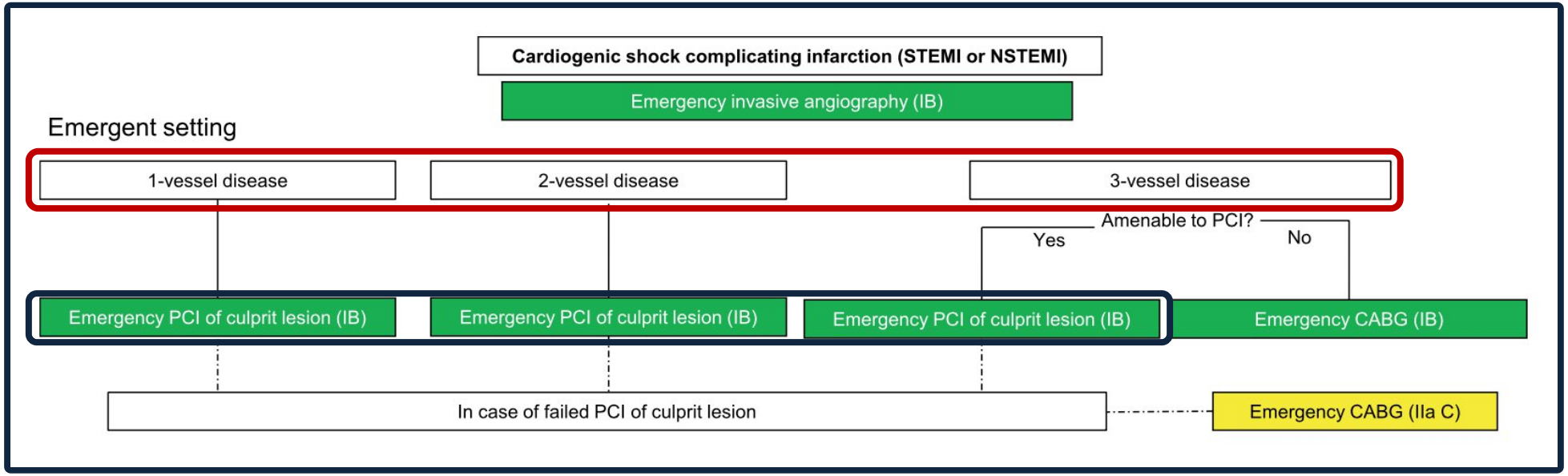
N Engl J Med 1999;341:625-34

N Engl J Med 2017; 377:2419-243

Treatment algorithm for the use of revascularization therapies depending on coronary anatomy



According to the best current evidence, in the vast majority of CS pts PCI should be limited to the culprit lesion with possible staged revascularization of other lesions

European Heart Journal (2019) 40, 2671–2683

Treatment algorithm for cardiogenic shock complicating myocardial infarction

EMERGENCY PCI CULPRIT LESION – IB
EMERGENCY CABG (IF NOT AMENABLE PCI)– IB

I B

NO TROUTINE PCI OF NON-IRA LESIONS – IIIB

III B

European Heart Journal (2019) 40, 2671–2683

Recommendations for NSTE-ACS with SHOCK

Routine immediate revascularization of non-culprit lesions in NSTE-ACS patients with multivessel disease presenting with CS is not recommended

III	B

Some specific angiographic scenarios, such as subtotal non-culprit lesions with reduced TIMI flow, or multiple possible culprit lesions may benefit from immediate multivessel PCI. This should be considered on an individual basis.

European Heart Journal (2021) 42, 1289-1367

Treatment algorithm for cardiogenic shock complicating myocardial infarction

INTRAVENOUS INOTROPES TO INCREASE CARDIAC AUTPUT– IIb C

IIb | C

VASOPRESSOR (NOREPINEPHRINE PREFERABLE OVER DOPAMINE) IN PRESENCE OF HYPOTENSION– IIb B

IIb | B

European Heart Journal (2019) 40, 2671–2683

MECHANISM OF ACTION AND HAEMODYNAMIC EFFECTS OF VASOCONSTRICTOR/INOTROPES

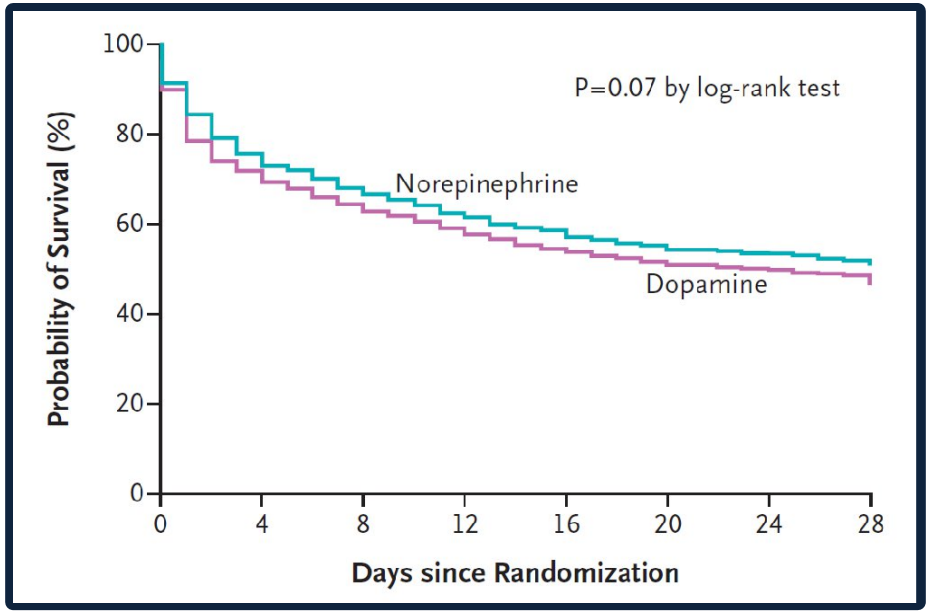
Medication	Usual infusion dose	Receptor binding				Haemodynamic effects
		α_1	β_1	β_2	DA	
Vasoconstrictor/inotropes						
Dopamine	0.5–2 mcg/kg/min	-	+	-	+++	↑ CO
	5–10 mcg/kg/min	+	+++	+	++	↑↑CO, ↑SVR
	10–20 mcg/kg/min	+++	++	-	++	↑↑SVR, ↑CO
Norepinephrine	0.05–0.4 mcg/kg/min	++++	++	+	-	↑↑SVR, ↑CO
Epinephrine	0.01–0.5 mcg/kg/min	++++	++++	+++	-	↑↑CO, ↑↑SVR
Inotropes						
Dobutamine	2.5–20 mcg/kg/min	+	++++	++	-	↑↑CO, ↓SVR, ↓PVR, MAP↓

European Heart Journal: Acute Cardiovascular Care 2020, Vol. 9(2) 183–197

Comparison of Dopamine and Norepinephrine

Variable	Dopamine (N=858)	Norepinephrine (N=821)	P Value
Arrhythmias — no. (%)	207 (24.1)	102 (12.4)	<0.001
Atrial fibrillation	176 (20.5)	90 (11.0)	
Ventricular tachycardia	21 (2.4)	8 (1.0)	
Ventricular fibrillation	10 (1.2)	4 (0.5)	

Dopamine was associated with significantly more adverse effects—mainly arrhythmic events—for the overall study cohort



N Engl J Med 2010;362:779-89

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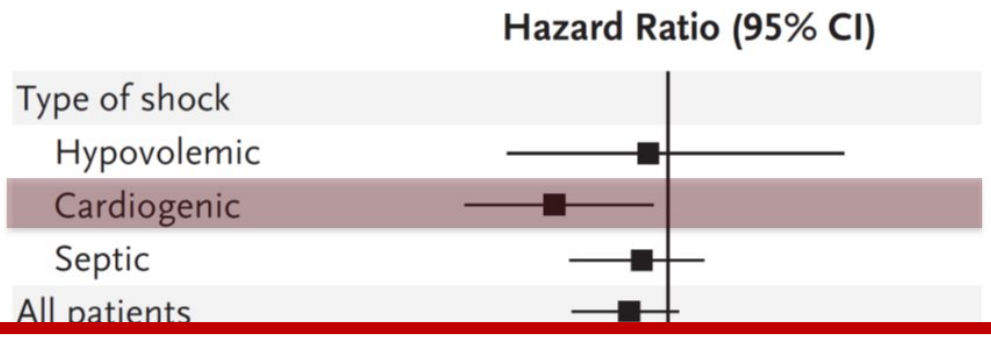
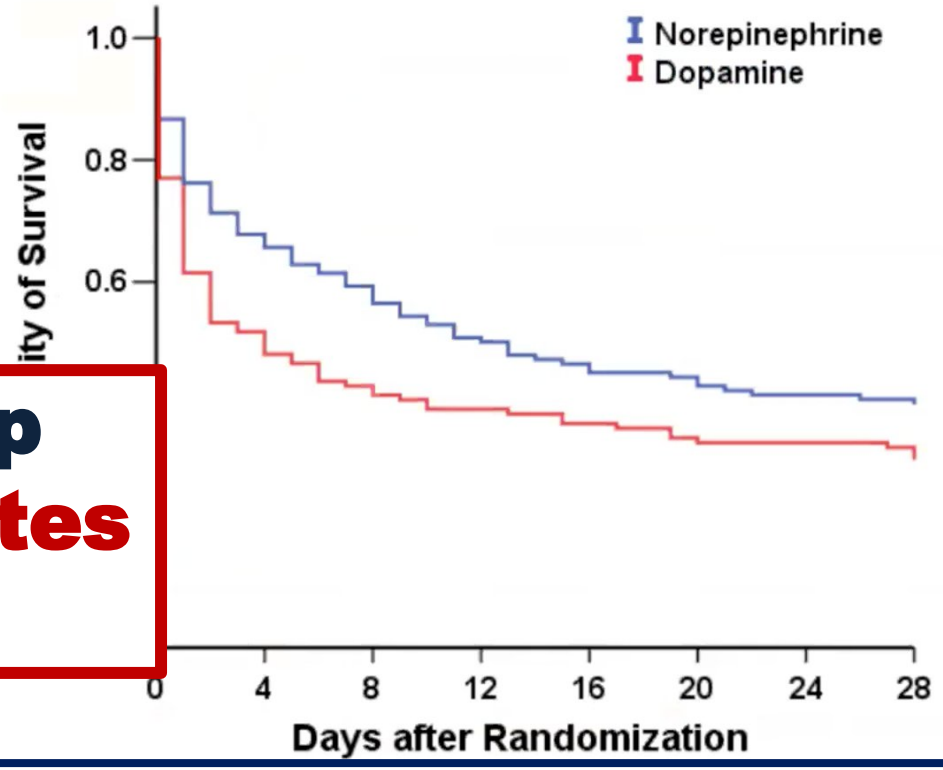
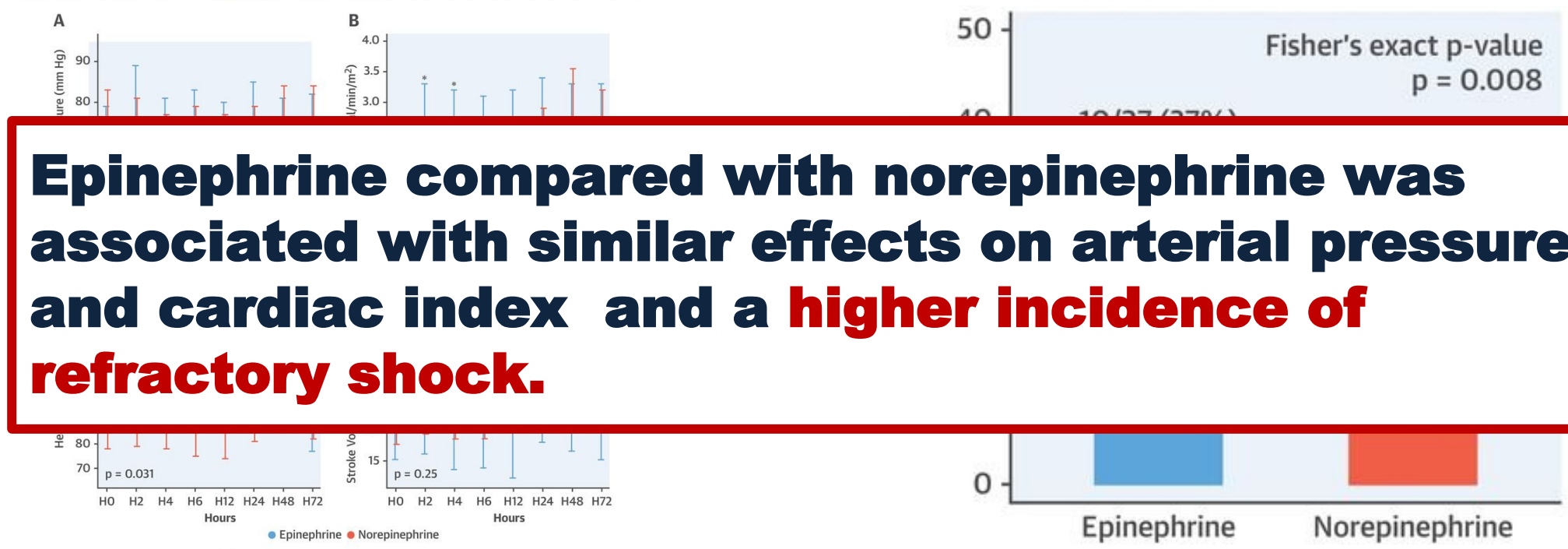




Cardiogenic Shock subgroup experienced lower death rates with norepinephrine

N Engl J Med 2010;362:779-89

Epinephrine versus Norepinephrine in ACS-CS



Epinephrine compared with norepinephrine was associated with similar effects on arterial pressure and cardiac index and a higher incidence of refractory shock.

Levy, B. et al. J Am Coll Cardiol. 2018;72(2):173–82.

Recommendations for the management of STEMI-CS

Inotropic/vasopressor agents may be considered for haemodynamic stabilization.	IIb	C

Intravenous inotropic agents or vasopressors are usually required to maintain an SBP >90 mmHg, and to increase cardiac output and improve vital organ perfusion.

Dobutamine is the initial therapy for patients with predominant low cardiac output, whereas norepinephrine may be safer and more effective than dopamine in patients with cardiogenic shock and severe hypotension

European Heart Journal (2018) 39, 119–177

Inotropic drugs and Vasopressors

- INCREASE CARDIAC OUTPUT AND MAINTAIN A SUFFICIENT BLOOD PRESSSURE
- INCREASE MYOCARDIAL OXYGEN CONSUMPTION AND VASOCONSTRICTION
- SHOULD BE ADMINISTERED AT THE LOWEST POSSIBLE DOSE AND FOR THE SHORTEST POSSIBLE DURATION
- NOREPINEPHRINE MAY BE THE VASOCONSTRICTOR OF CHOICE

RECOMMENDED CRITICAL CARE UNIT MONITORING IN SHOCK

Monitoring parameter	Frequency	Comment/rationale
Invasive monitoring		
Arterial blood pressure monitoring	Continuous	Consider continuing until full hemodynamic stabilization has been achieved for 12–24 h
Central venous pressure (CVP)	Continuous	A central line is required for delivery of vasoactive medications. Single point in time CVP measurements may be unreliable measures of fluid status, but longitudinal CVP trends may provide information on trends in fluid status
Central venous oxygen saturation	Every 4 h	Trends in $Scv0_2$ in patients with a central line can be used to monitor trends in cardiac output
Urine output	Every hour	Urine output along with serum creatinine monitoring are markers of renal perfusion and acute kidney injury
Pulmonary artery catheter or non-invasive cardiac output monitor	Selected use	Consider using early in the treatment course in patients not responsive to initial therapy, or in cases of diagnostic or therapeutic uncertainty

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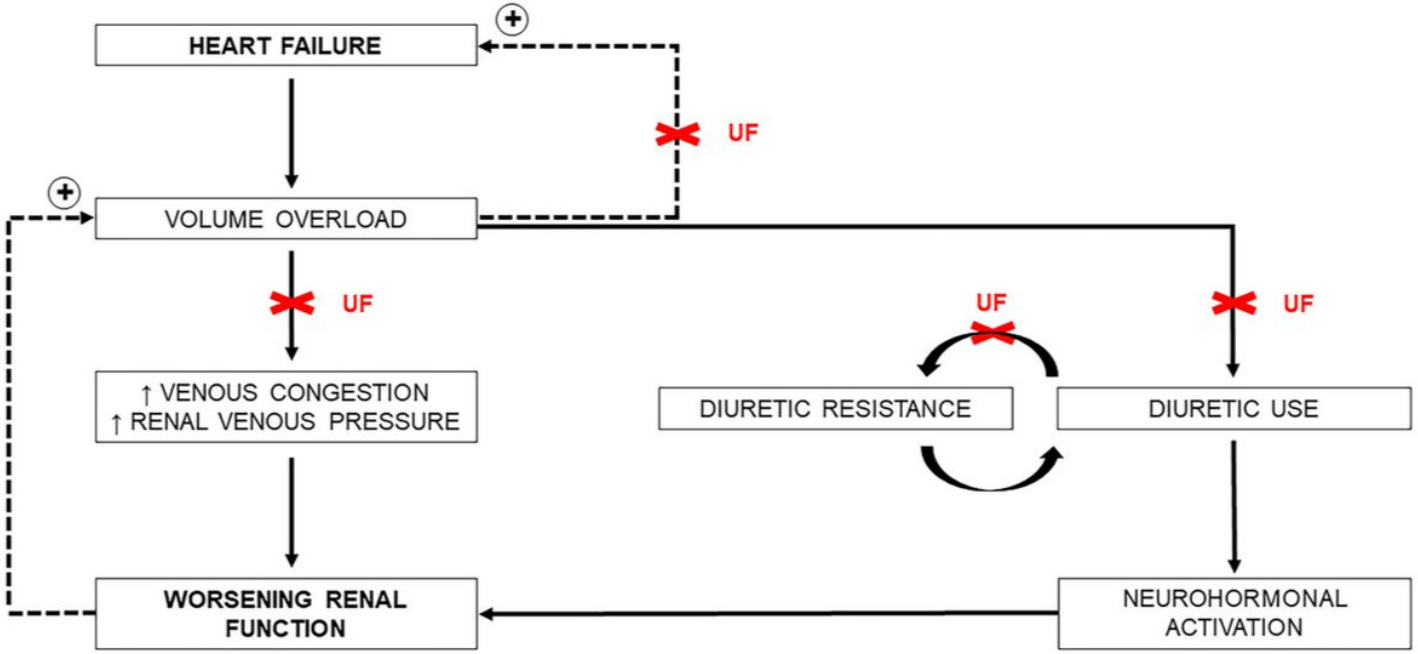
Beneficial effects of ultrafiltration in heart failure with fluid overload.

Ultrafiltration in refractory congestion not responding to diuretics (IIb/C)



Venous congestion and renal venous pressure are reduced decreasing renal damage with further advantages on fluid overload resolution, contributing to restore diuretic responsiveness in diuretic resistant patients.

UF removes isotonic fluid, allowing to interrupt the vitious circle between heart failure and fluid overload.

Rev. Cardiovasc. Med. 2021, 22(4), 1311–1322

MECHANICAL VENTILATION

Ventilatory support/O_2 according to blood gases (1C)

- IMPROVE OXYGENATION
- REDUCES THE WORK OF BREATHING
- HAVE POSITIVE EFFECTS ON PCWP AND/OR LEFT VENTRICULAR DYSFUNCTION,
- COMPROMISE VENOUS RETURN, PRELOAD, CARDIAC OUTPUT PARTICULARLY IN RV DYSFUNCTION

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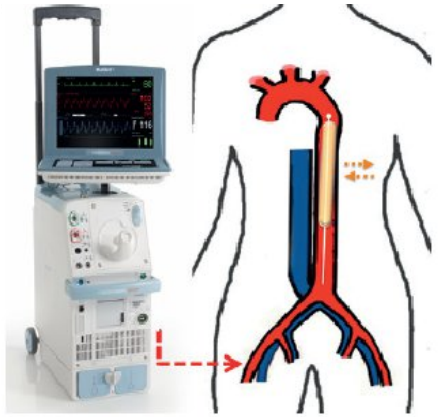
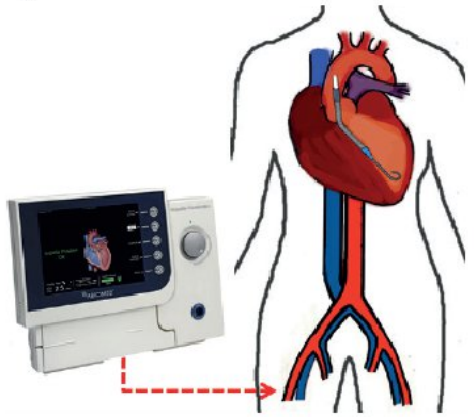
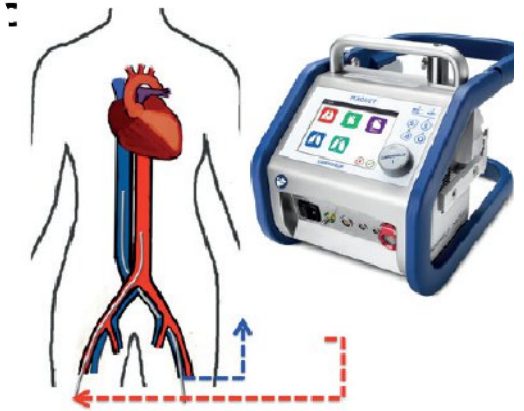
MECHANICAL CIRCULATORY SUPPORT

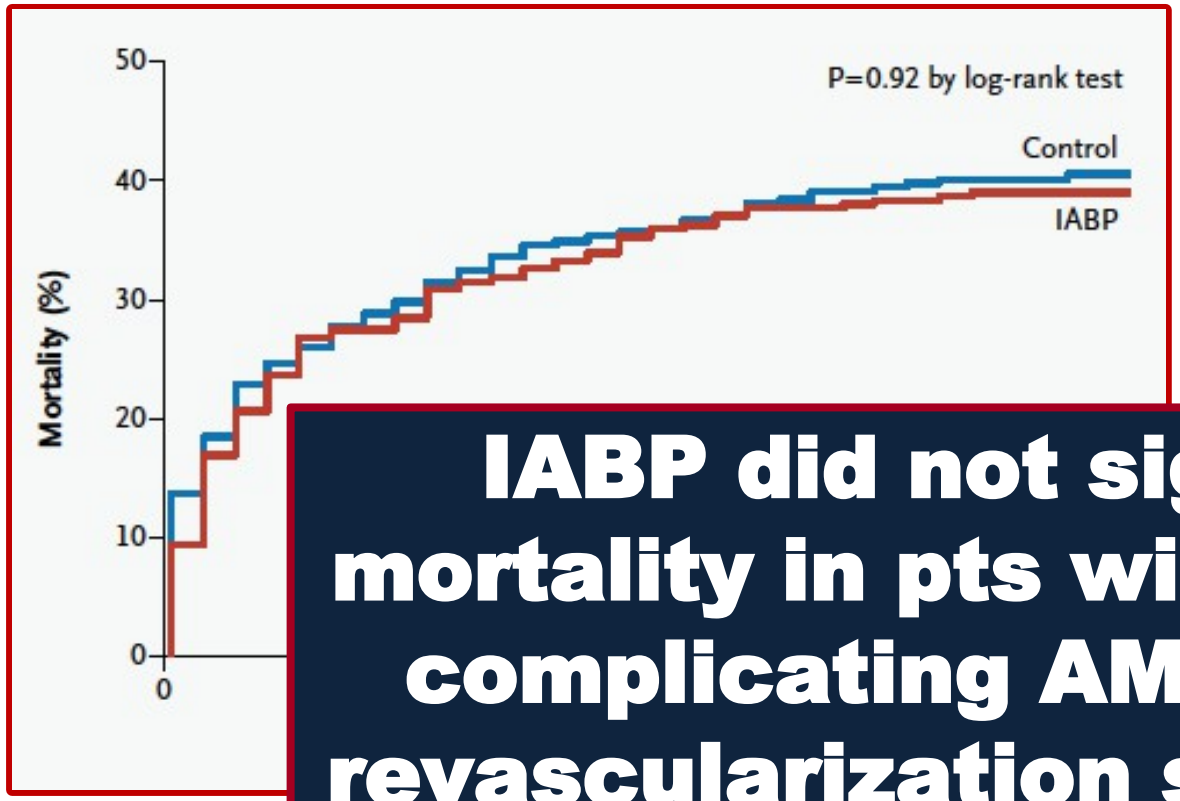


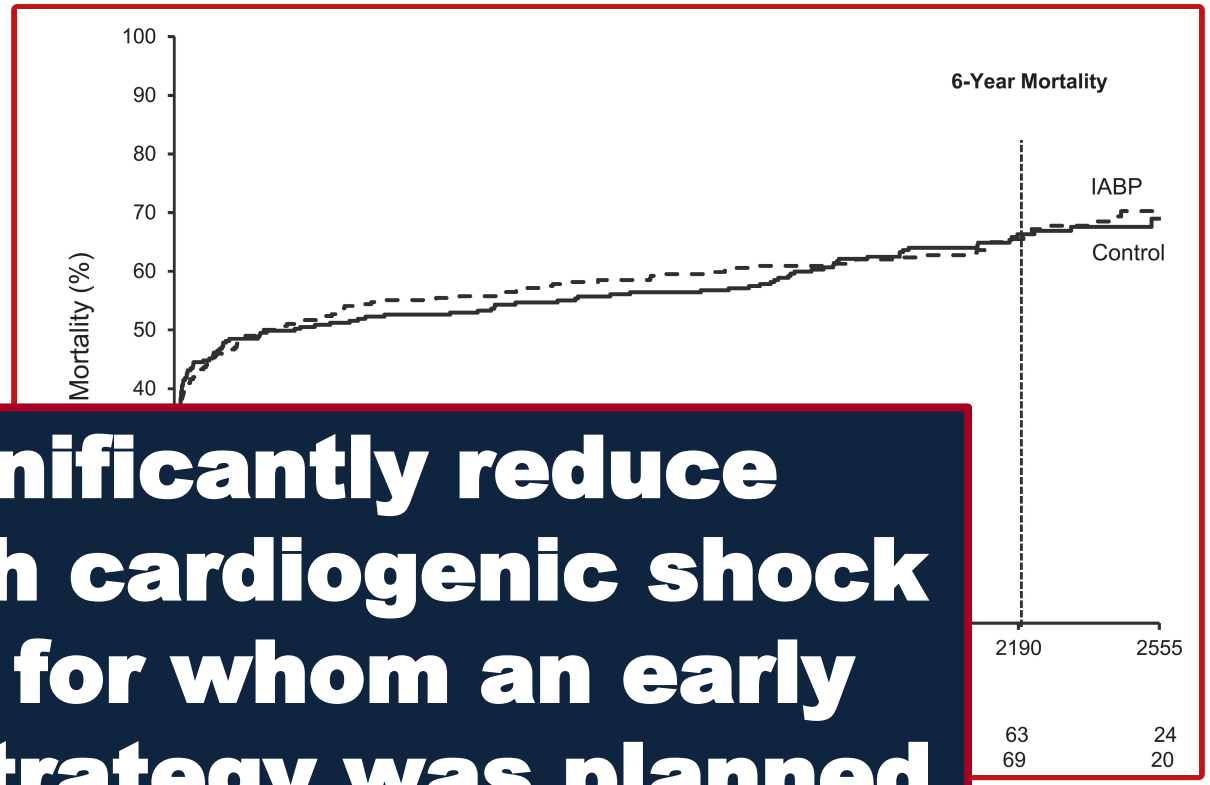




	IABP	IMPELLA	ECMO
Portata nativa	= o lieve ↑	= o ↑ ↓	↓ ↓
Portata totale sistemica	= portata nativa	↑ ↑ ↑ assistita	↑ ↑ ↑
Portata polmonare	= portata nativa	↑ ↑ ↑ non assistita	↓ ↓ ↓
Ventricolo sinistro	scaricato	(molto) scaricato	sovraccaricato
⇒ Postcarico	↓	(↓ ↓)	↑ ↑ ↑
Carico ventricolo DX	= o lieve ↑	↑ ↑ ↑	↓ ↓ ↓

IABP-SHOCK II Trial



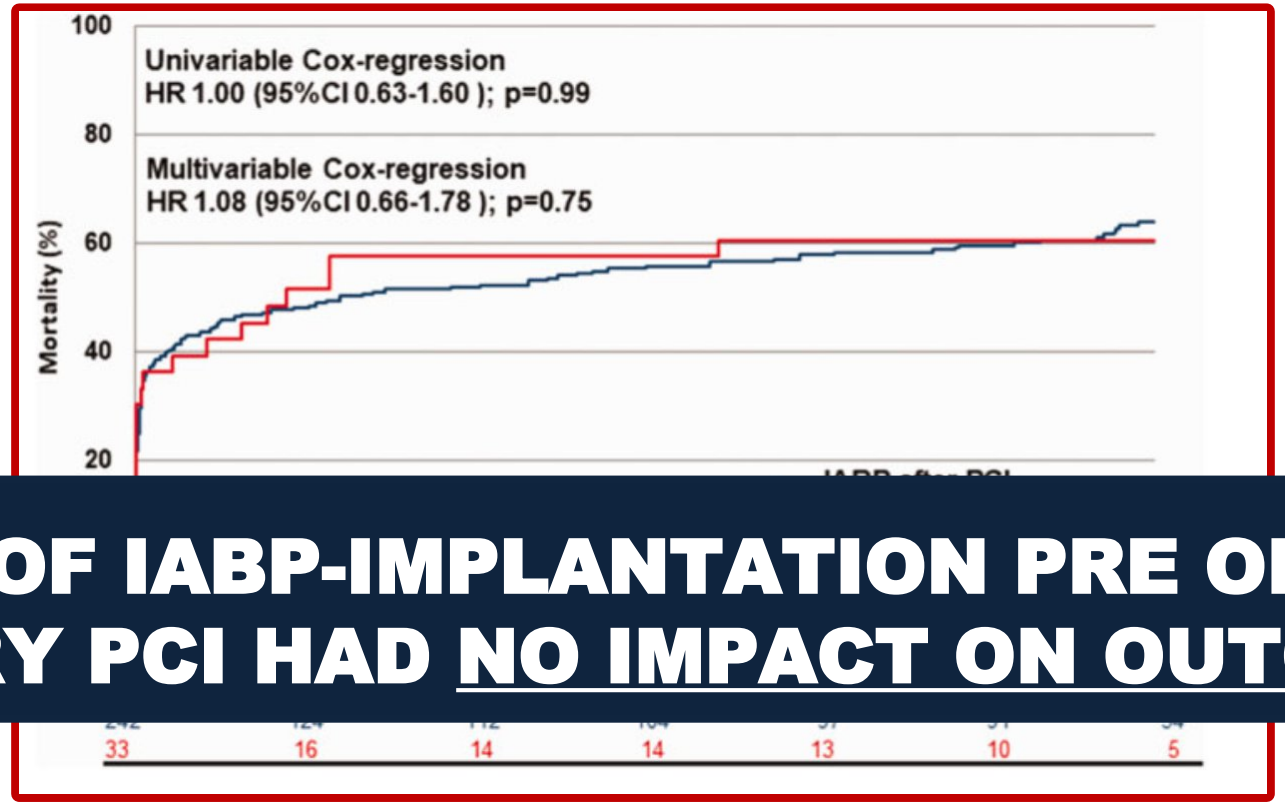


IABP did not significantly reduce mortality in pts with cardiogenic shock complicating AMI for whom an early revascularization strategy was planned

N Engl J Med 2012;367:1287-960

Circulation 2019; 139;395-403

Impact of timing of IABP on mortality in cardiogenic shock a subanalysis of the IABP-SHOCK II trial



TIMING OF IABP-IMPLANTATION PRE OR POST PRIMARY PCI HAD NO IMPACT ON OUTCOME.

European Heart Journal: Acute Cardiovascular Care (2021) 10, 54–61

IABP IS NOT ROUTINELY RECOMMENDED IN POST-MI CARDIOGENIC SHOCK

III	B

- NO DIFFERENCE IN THE PRIMARY STUDY ENDPOINT OF 30-DAY MORTALITY
- NO DIFFERENCE IN MORTALITY AFTER ONE YEAR
- NO BENEFIT ON LONG-TERM OUTCOME
- NO DIFFERENCE BASED ON TIME OF IMPLANTATION

European Heart Journal (2019) 40, 2671–2683

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IABP IN CARDIOGENIC SHOCK

IABP IS NOT ROUTINELY RECOMMENDED IN POST-MI CARDIOGENIC SHOCK

III	B

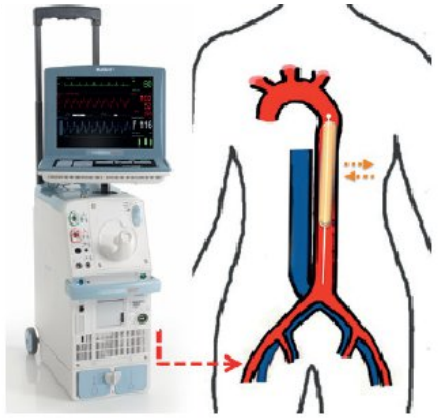
IABP SHOULD BE CONSIDERED FOR ACS-RELATED MECHANICAL COMPLICATIONS

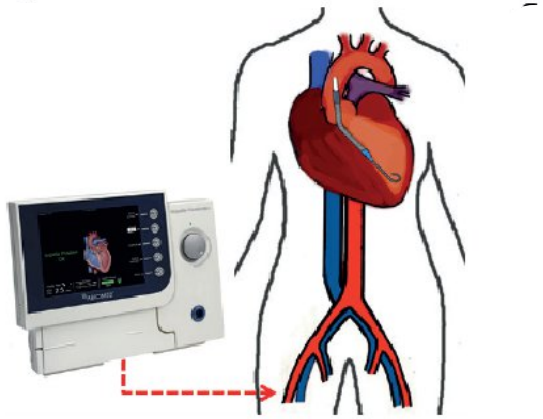
IIa	C

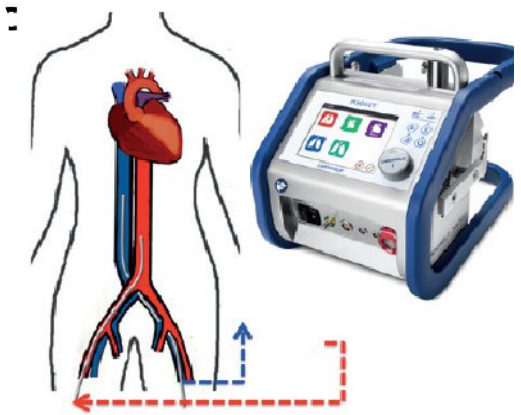
The routine use of IABP cannot be recommended based on the current evidence and should be limited to patients with mechanical complications

ESC Guidelines - European Heart Journal (2021) 1-128

MECHANICAL CIRCULATORY SUPPORT







	IABP	IMPELLA	ECMO
Portata nativa	= o lieve ↑	= o ↑ ↓	↓ ↓
Portata totale sistemica	= portata nativa	↑ ↑ ↑ assistita	↑ ↑ ↑
Portata polmonare	= portata nativa	↑ ↑ ↑ non assistita	↓ ↓ ↓
Ventricolo sinistro	scaricato	(molto) scaricato	sovraccaricato
Postcarico	↓	(↓ ↓)	↑ ↑ ↑
Carico ventricolo DX	= o lieve ↑	↑ ↑ ↑	↓ ↓ ↓

SHORT-TERM MECHANICAL CIRCULATORY SUPPORT IN CARDIOGENIC SHOCK

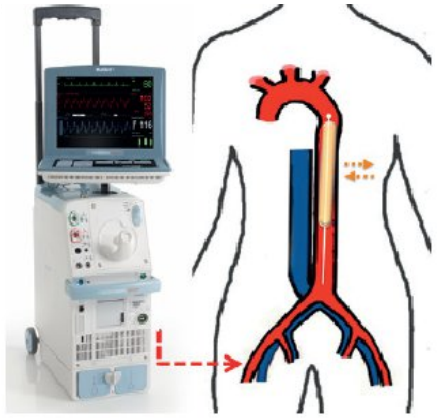
SHORT-TERM MCS SHOULD BE CONSIDERED IN PATIENTS WITH CARDIOGENIC SHOCK AS A BTR, BTD, BTB.

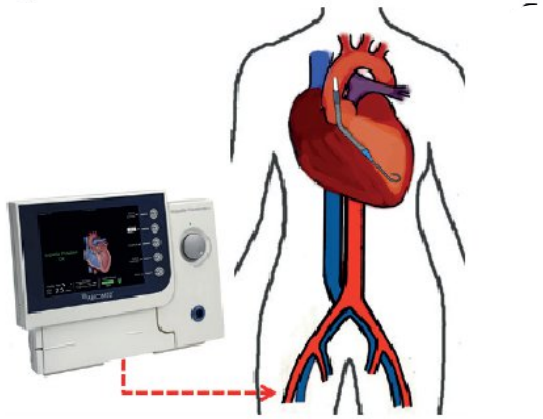
IIa	C

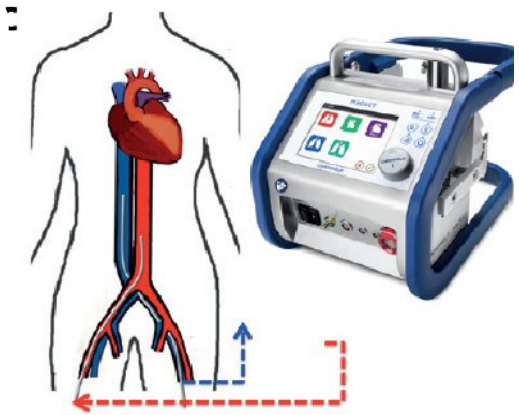
SHORT-TERM MCS MAY BE NECESSARY TO AUGMENT CARDIAC OUTPUT AND SUPPORT END-ORGAN PERFUSION

ESC Guidelines - European Heart Journal (2021) 1-128

MECHANICAL CIRCULATORY SUPPORT







	IABP	IMPELLA	ECMO
Portata nativa	= o lieve ↑	= o ↑ ↓	↓ ↓
Portata totale sistemica	= portata nativa	↑ ↑ ↑ assistita	↑ ↑ ↑
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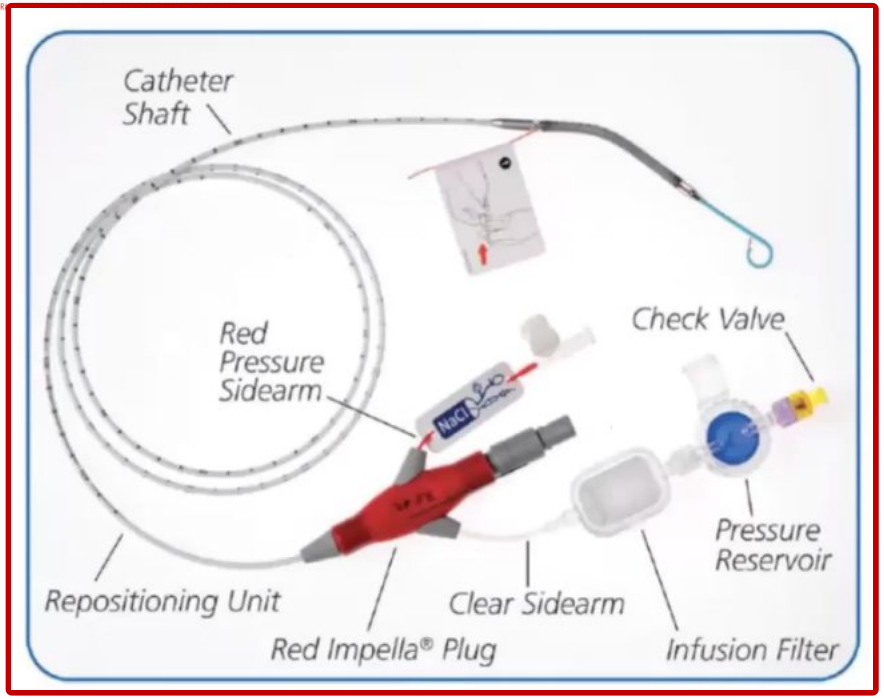
Carico ventricolo DX	= o lieve ↑	↑ ↑ ↑	↓ ↓ ↓

IMPELLA

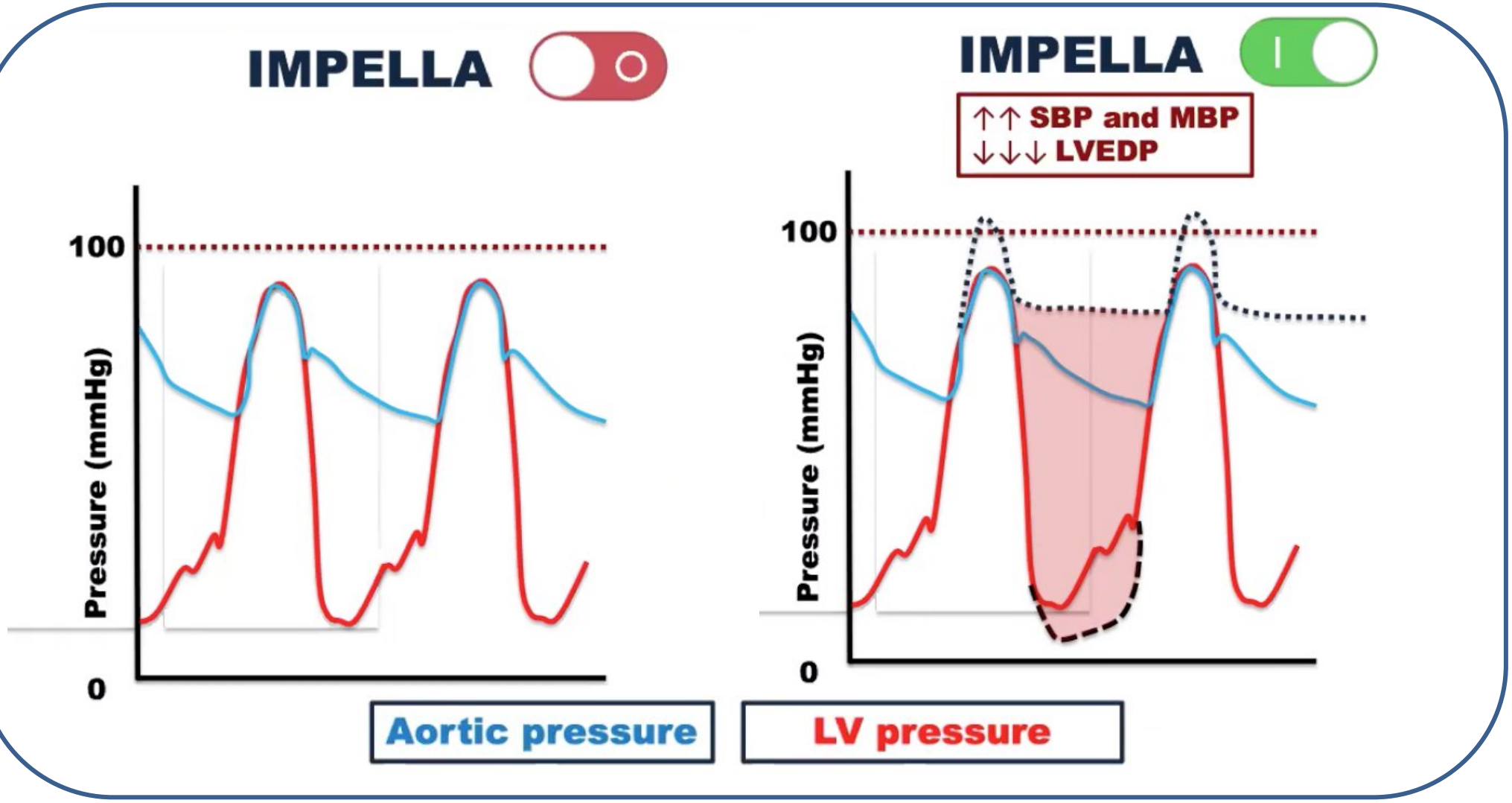


A small catheter-mounted pump inserted percutaneously through a peripheral artery and positioned across the aortic valve with its distal end in the LV and its outlet in the proximal aorta.

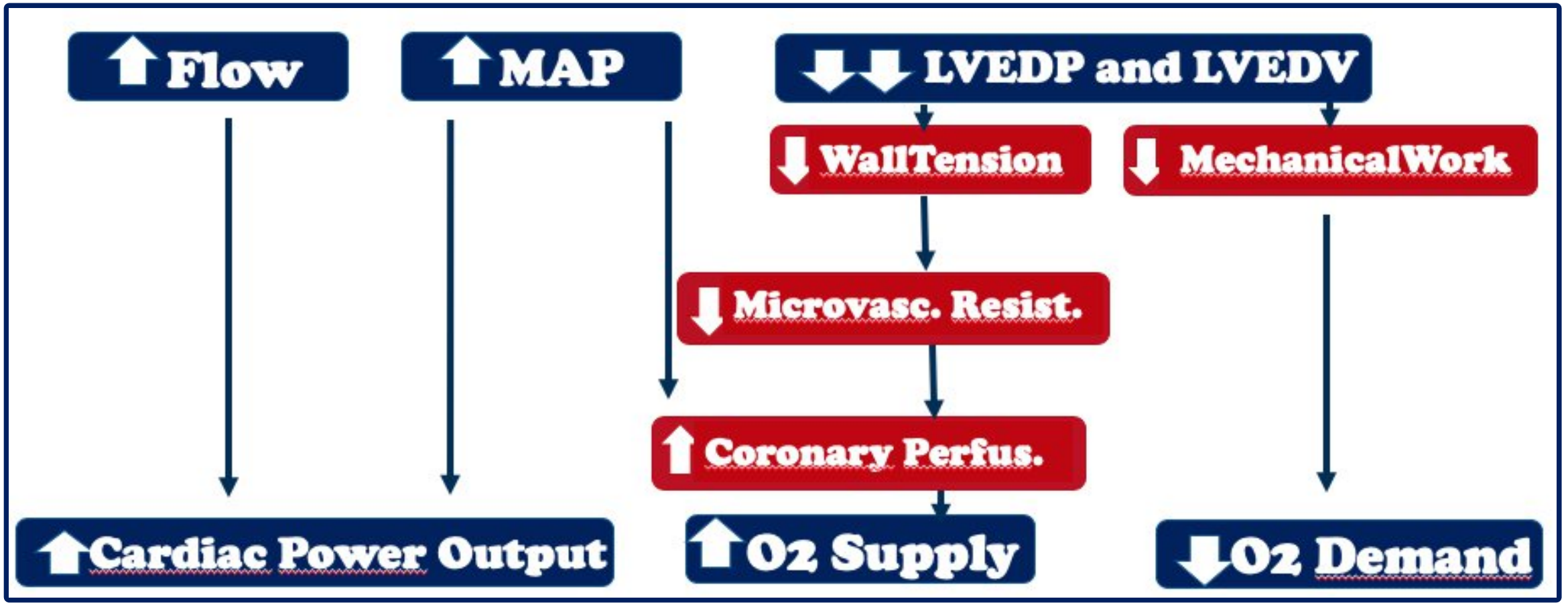
	Impella 2.5	Impella CP	Impella 5.0
Flusso (L/min)	2.5	3.7 – 4.0	5.0
Supporto circolatorio	Parziale	Parziale - Alto	Alto flusso
Dimensione catetere	9 F	9 F	9 F
Dimensione pompa	12 F	14 F	21 F
Metodo di impianto	Percutaneo	Percutaneo	Esposizione arteria

It draws blood from the LV and pumps it into the aorta and generates forward blood flow from the LV to the aorta unloading the LV and improving forward blood flow.

IMPELLA-HEMODYNAMIC EFFECTS



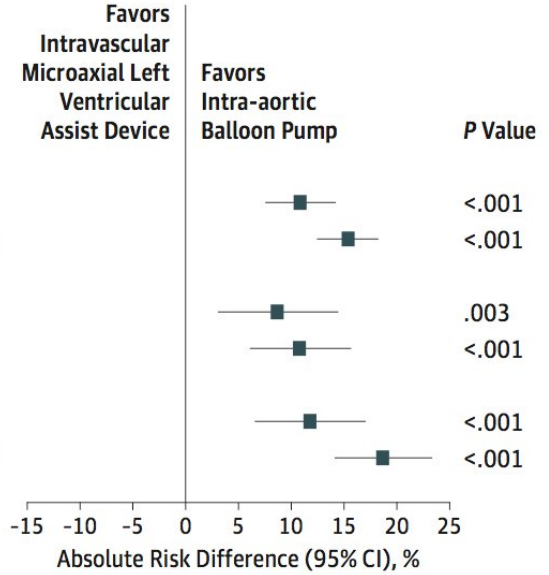
HEMODYNAMIC EFFECTS OF IMPELLA SUPPORT



Am J Cardiol 2017;119:845e 851

INTRAVASCULAR MICROAXIAL LEFT VENTRICULAR ASSIST DEVICE VS IABP

	Intravascular Microaxial Left Ventricular Assist Device		Intra-aortic Balloon Pump		Absolute Risk Difference (95% CI), %	*P* Value
	No. of Patients	Patients, %	No. of Patients	Patients, %		
Overall (n = 1680 matched pairs)						
Mortality	756	45.0	573	34.1	10.9 (7.6-14.2)	<.001
Major bleeding	526	31.3	268	16.0	15.4 (12.5-18.2)	<.001
Device placement before initiation of percutaneous coronary intervention (n = 573 matched pairs)						
Mortality	261	45.5	211	36.8	8.7 (3.1-14.4)	.003
Major bleeding	157	27.4	95	16.6	10.8 (6.1-15.6)	<.001
Device placement after initiation of percutaneous coronary intervention (n = 662 matched pairs)						
Mortality	291	44.0	213	32.2	11.8 (6.6-17.0)	<.001
Major bleeding	228	34.4	104	15.7	18.7 (14.2-23.3)	<.001



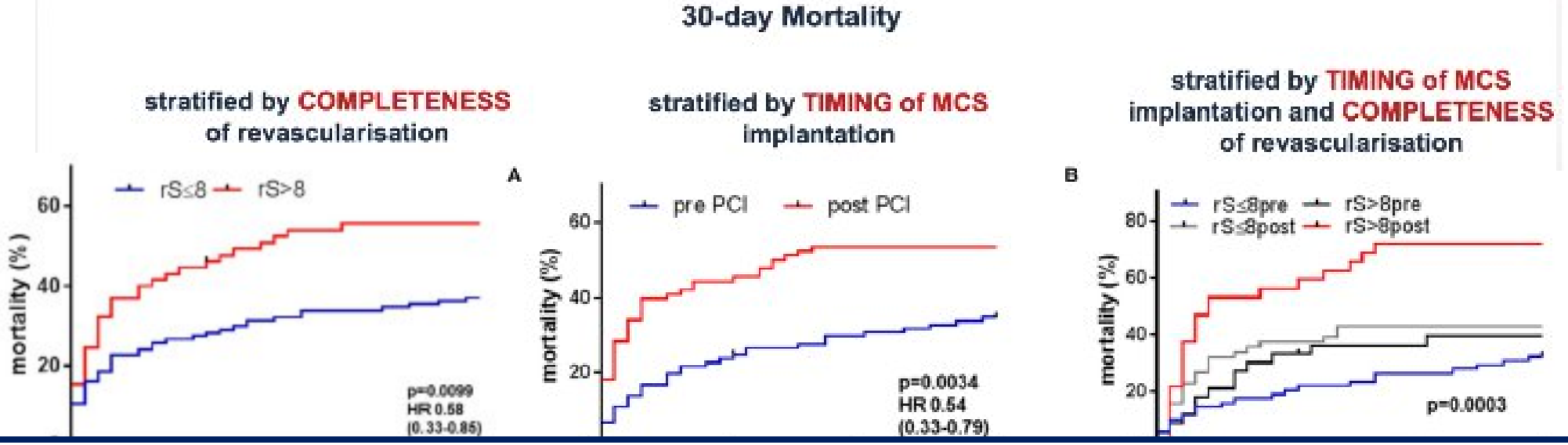
Among patients undergoing PCI for AMI complicated by cardiogenic shock, use of an intravascular microaxial LVAD compared with IABP was associated with higher adjusted risk of in-hospital death and major bleeding complications

JAMA. 2020;323(8):734-745

PLACE 9ª Edizione

IMPELLA IN AMI-CS PATIENTS

202 consecutive Impella-treated AMI-CS patients (94 cardiac arrest) at four European high-volume shock centres

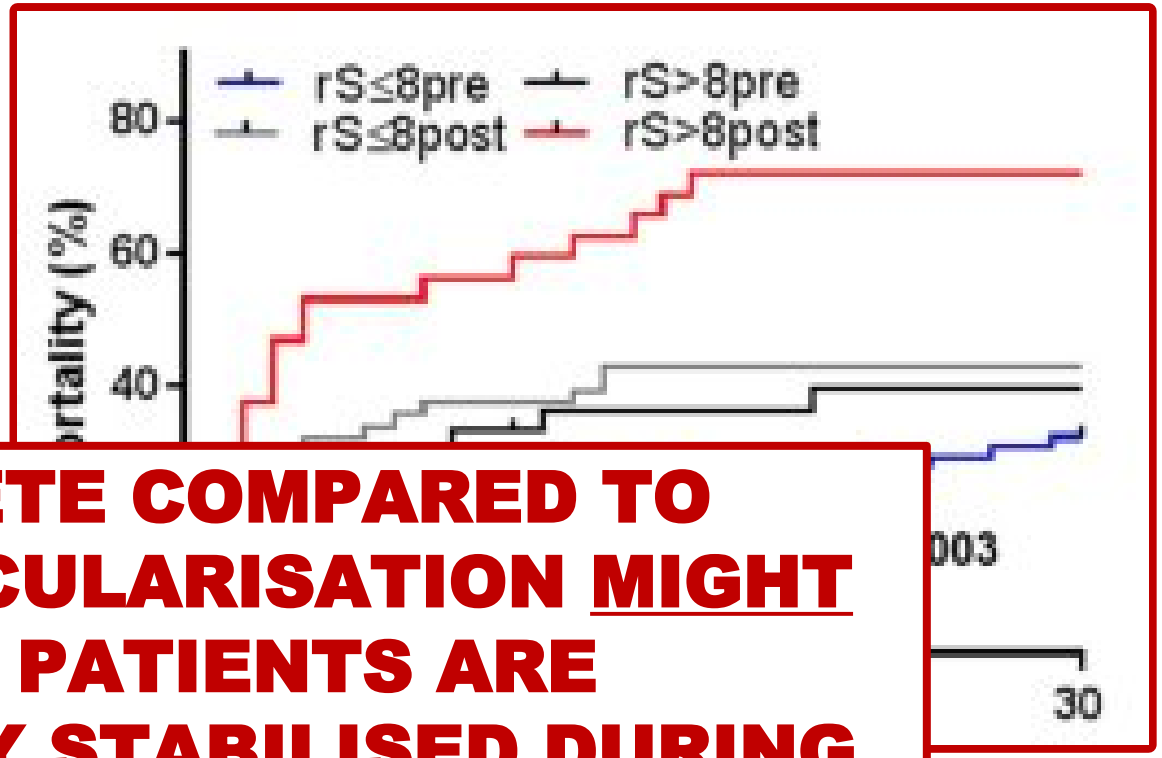


THIRTY-DAY MORTALITY IN ACUTE MYOCARDIAL INFARCTION CARDIOGENIC SHOCK ON IMPELLA DEPENDING ON TIMING OF IMPELLA SUPPORT AND COMPLETENESS OF REVASCULARISATION.

Front. Cardiovasc. Med. 2021, 8, 678748.

COMPLETE REVASCULARISATION IN IMPELLA-SUPPORTED AMI-CS PTS

Patients with both pre-PCI Impella implantation and complete revascularisation had significantly lower mortality (33%) than those with inco revascul implanta



RESULTS OF COMPLETE COMPARED TO INCOMPLETE REVASCULARISATION MIGHT BE DIFFERENT WHEN PATIENTS ARE HAEMODYNAMICALLY STABILISED DURING THE REVASCULARISATION PROCEDURE

Front. Cardiovasc. Med. 2021, 8, 678748.

INTRAVASCULAR MICROAXIAL LEFT VENTRICULAR ASSIST DEVICE IN AMI-CS

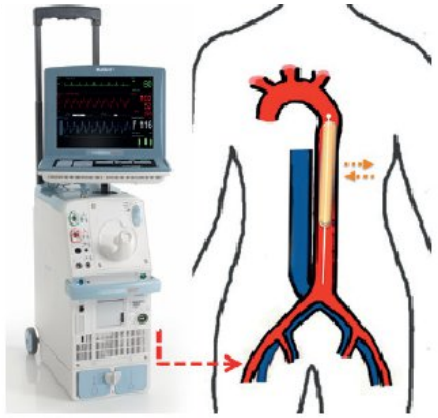
Microaxial Left Ventricular Assist Devices
In Search of an Appropriate Indication

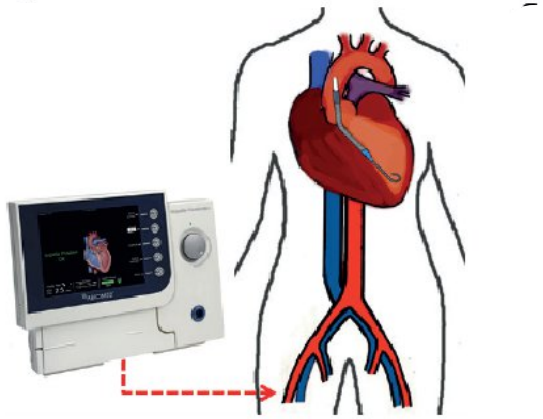
Holger Thiele, MD; Steffen Desch, MD; Anne Freund, MD

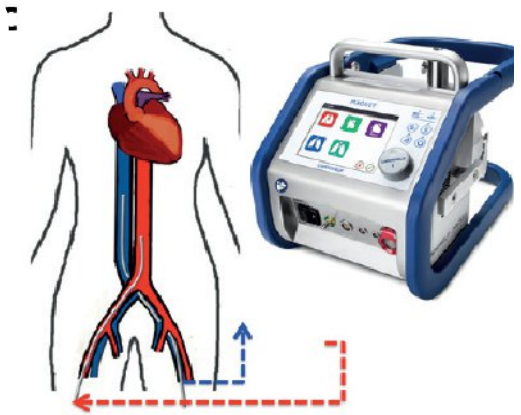
The results of these trials provide evidence to support a more restrictive use of these devices and as based on current guidelines, only in selected patients with refractory cardiogenic shock

JAMA. 2020;323(8):716-718

MECHANICAL CIRCULATORY SUPPORT







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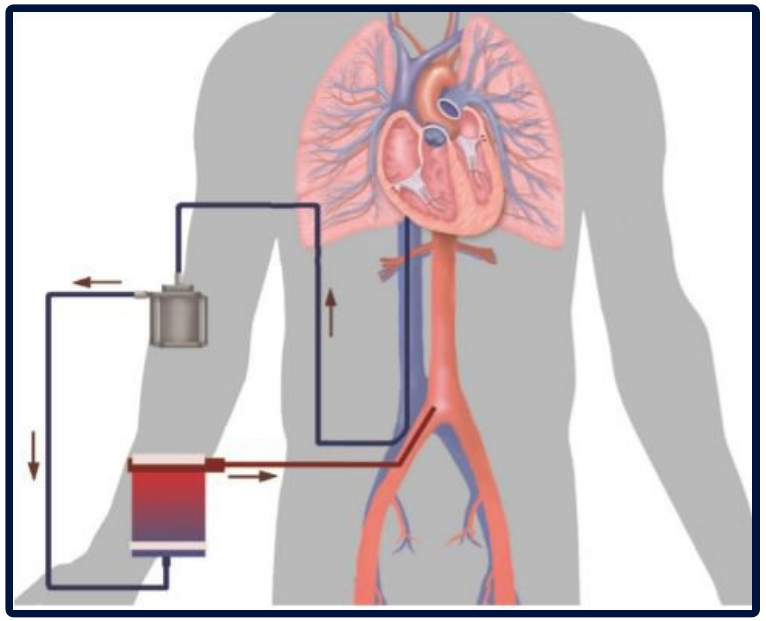
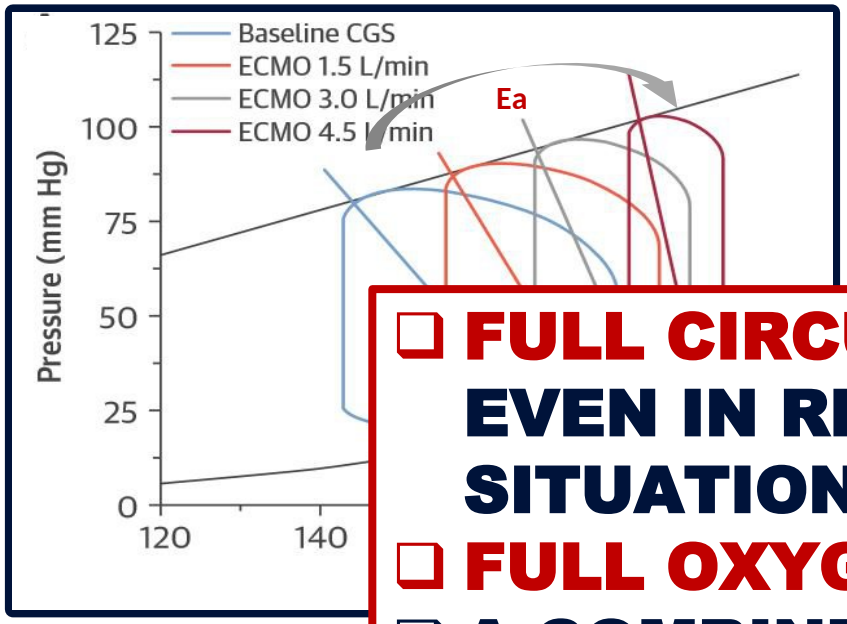
Extracorporeal membrane oxygenation - ECMO

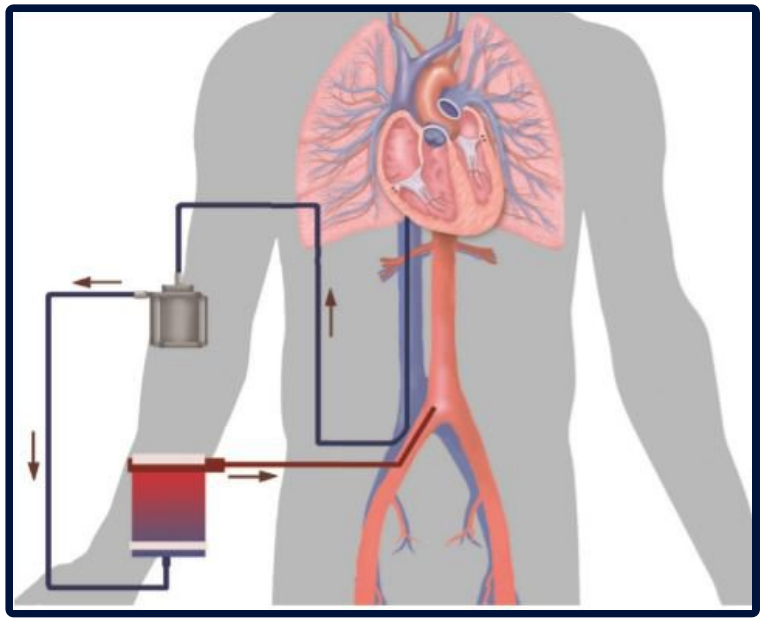


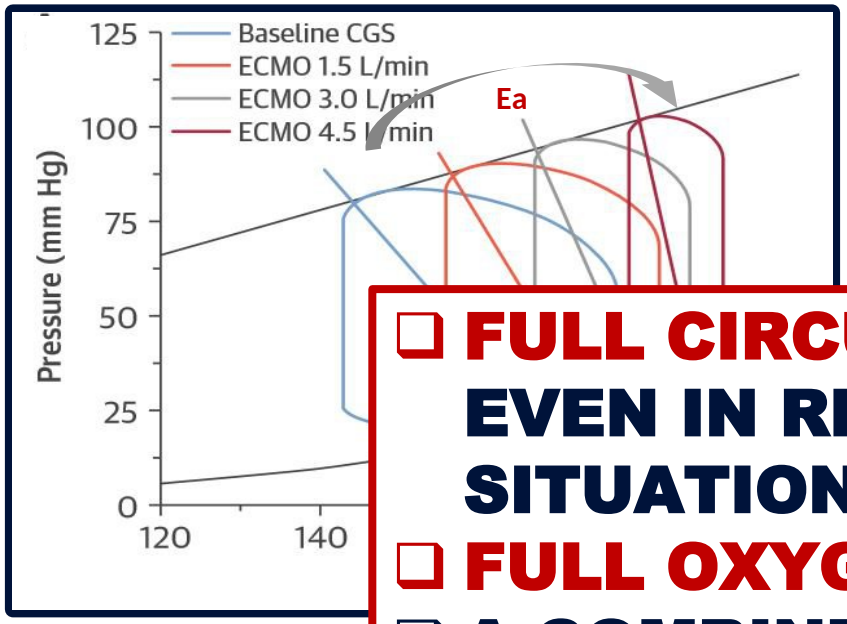


- **FULL CIRCULATORY SUPPORT EVEN IN RESUSCITATION SITUATIONS**
- **FULL OXYGENATION**
- **A COMBINED SUPPORT OF THE RIGHT AND LEFT VENTRICLES**
- **INCREASE IN AFTERLOAD**

Burkhoff et all, JACC 2015

Extracorporeal membrane oxygenation - ECMO





- **FULL CIRCULATORY SUPPORT EVEN IN RESUSCITATION SITUATIONS**
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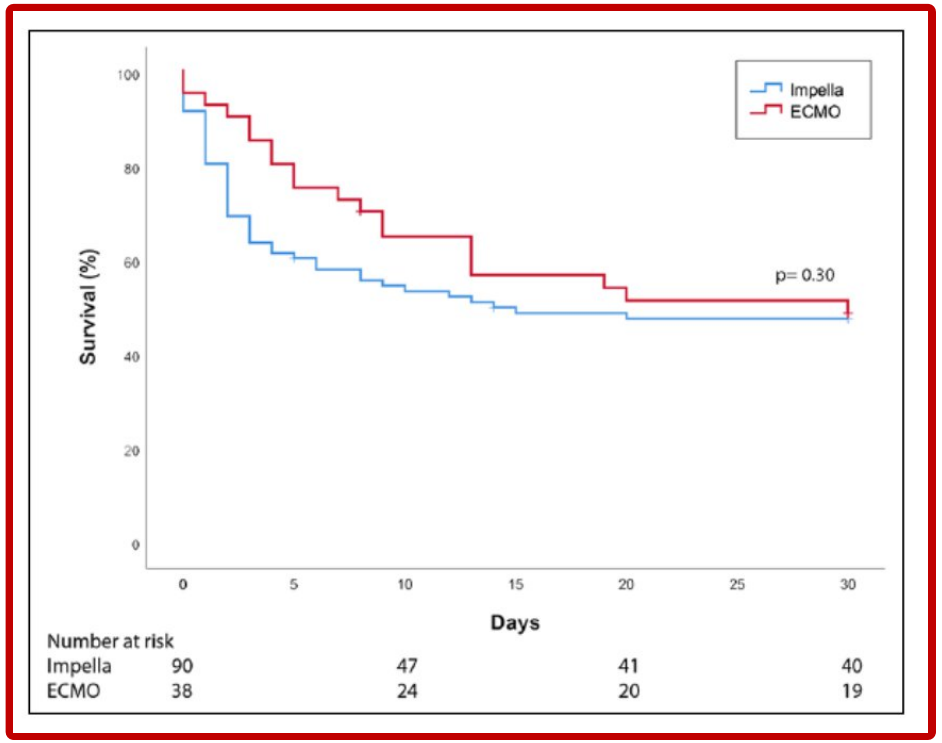
Burkhoff et all, JACC 2015

Mechanical circulatory support in cardiogenic shock from acute myocardial infarction: Impella CP/5.0 versus ECMO

- **Patients treated with Impella CP/5.0 or ECMO for cardiogenic shock after myocardial infarction did not differ in 30-day mortality.**
- **More device-related complications occurred with ECMO compared to Impella support.**

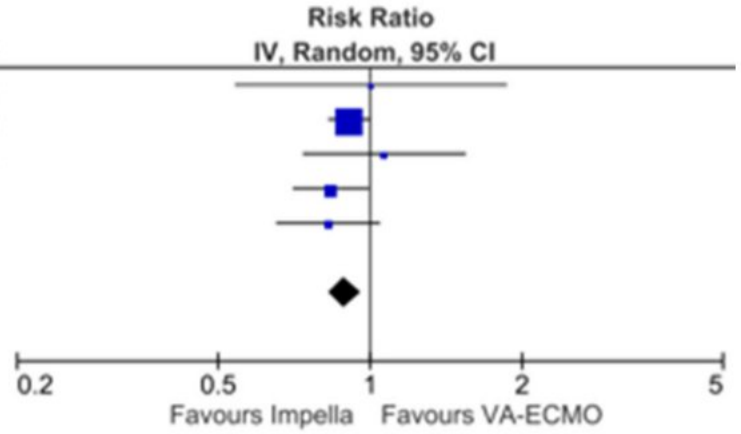


European Heart Journal: Acute Cardiovascular Care 2020, Vol. 9(2) 164–172

Meta-analysis of in-hospital mortality with Impella versus VA-ECMO in AMI-CS

Study or Subgroup	Impella Events	Impella Total	VA-ECMO Events	VA-ECMO Total	Weight	Risk Ratio IV, Random, 95% CI	Year
Garan 2019	14	31	9	20	1.5%	1.00 [0.54, 1.87]	2019
Lemor 2020	2372	5730	255	560	64.3%	0.91 [0.83, 1.00]	2020
Karami 2020	48	90	19	38	4.3%	1.07 [0.74, 1.55]	2020
Karatolios 2021	157	300	77	123	19.4%	0.84 [0.70, 0.99]	2021
Syntila 2021	61	105	38	54	10.5%	0.83 [0.65, 1.05]	2021
Total (95% CI)		**6256**		**795**	**100.0%**	**0.89 [0.83, 0.96]**	
Total events	2652		398				

Heterogeneity: Tau² = 0.00; Chi² = 2.12, df = 4 (P = 0.71); I² = 0%
Test for overall effect: Z = 2.90 (P = 0.004)

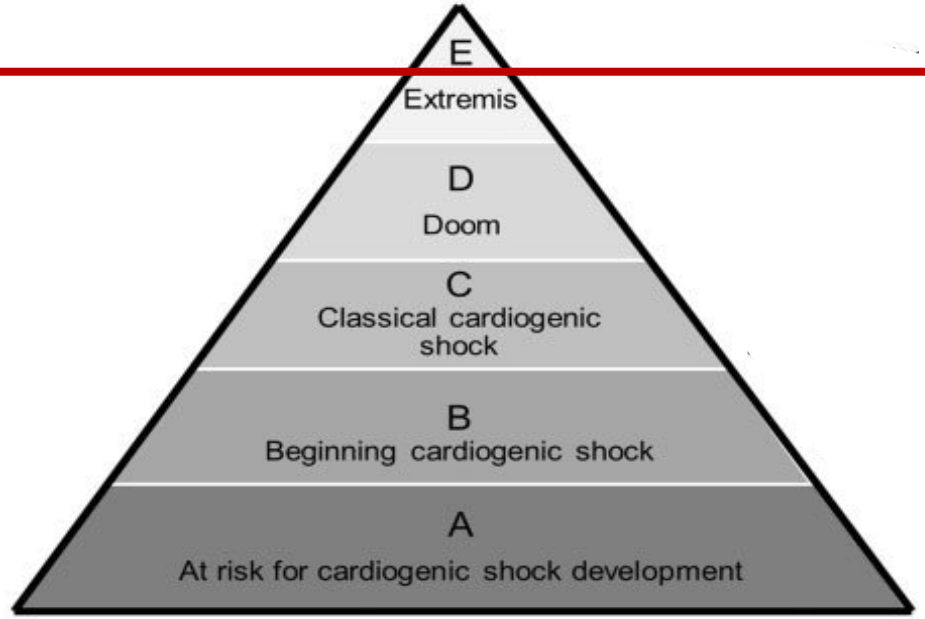


Both MCS modalities appear appropriate to support AMI-CS, but that Impella may be more well-suited for this subset of cardiogenic shock patients, with modest reduction observed in short- and medium-term mortality and complication rates.

J. Clin. Med. 2022, 11, 3955

Extracorporeal membrane oxygenation - ECMO

E, ESPECIALLY IN CASE OF COMBINED RESPIRATORY INSUFFICIENCY OR REFRACTORY CARDIAC ARREST, IN BIVENTRICULAR INJURY OR ISOLATED RV FAILURE



European Heart Journal: Acute Cardiovascular Care 2020, Vol. 9(2) 183–197

CARDIOGENIC SHOCK AND ACUTE CORONARY SYNDROMES

1. **Cardiogenic shock complicates the management of 7–10% of patients with ACS, and carries a high mortality rate (40–50%).**
2. **Left ventricular dysfunction is the commonest cause of cardiogenic shock complicating ACS**
3. **Early revascularization is the most important and currently only evidence-based treatment strategy and PCI should be limited to the culprit lesion.**

CARDIOGENIC SHOCK AND ACUTE CORONARY SYNDROMES

4. **Inotropic agents or vasopressors are usually required to maintain an SBP >90 mmHg and to increase cardiac output and improve vital organ perfusion-** norepinephrine preferable over dopamine

5. **Short-term MSC should be considered, to augment cardiac output and support end-organ perfusion**

CARDIOGENIC SHOCK AND ACUTE CORONARY SYNDROMES

6. Emerging observational experience suggested that key factors for improving clinical outcomes could be

- an early implantation of MCS prior to PCI,
- the performance of an a 'tailored' revascularization
- the implementation of shock teams (critical care cardiology, interventional cardiology, and cardiac surgery)
- the implementation of a CS regional network with standardized referral protocols