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ECMO and Other Short-Term MCS: What Every Surgeon Needs to Know

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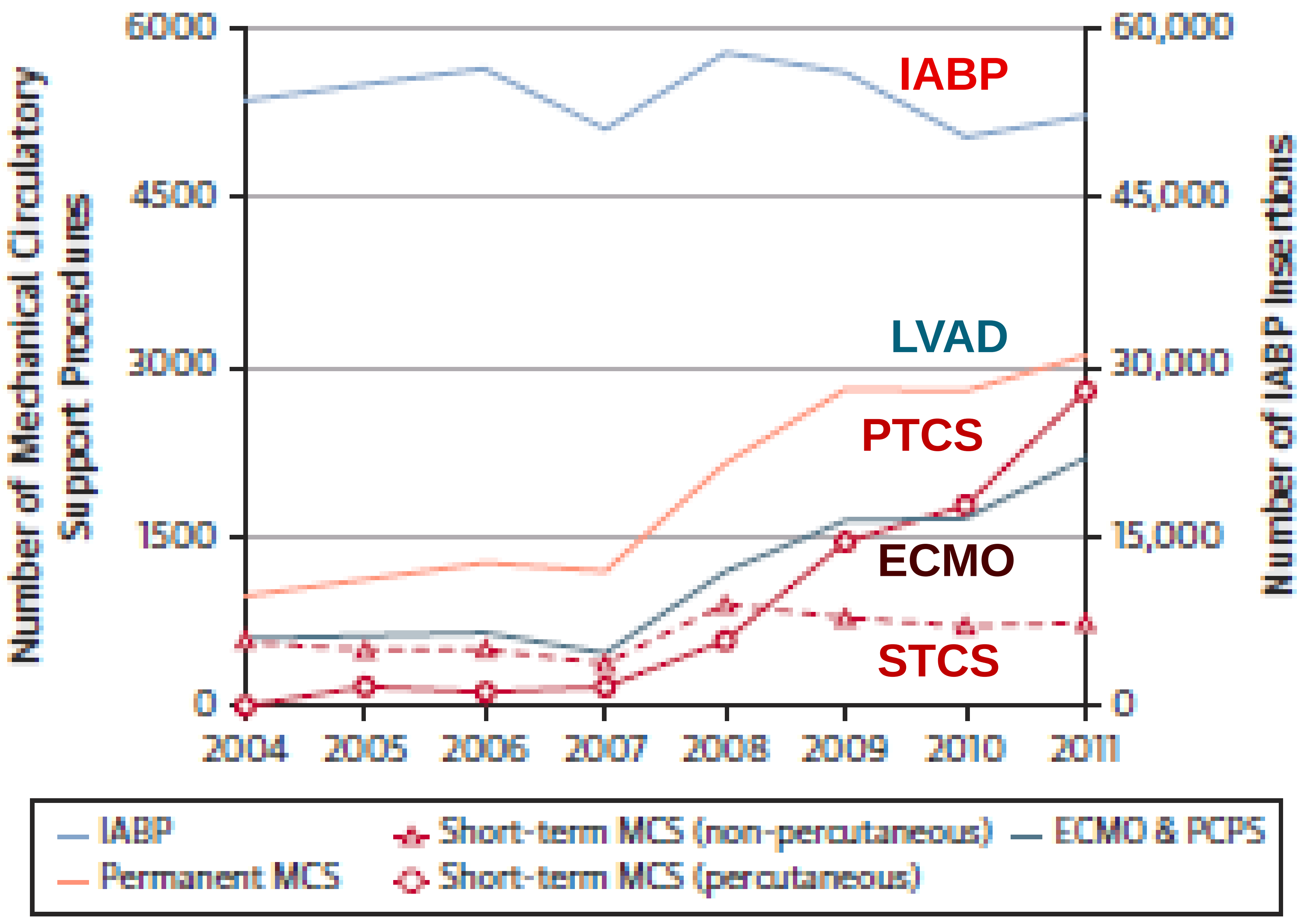
The Society of Thoracic Surgeons

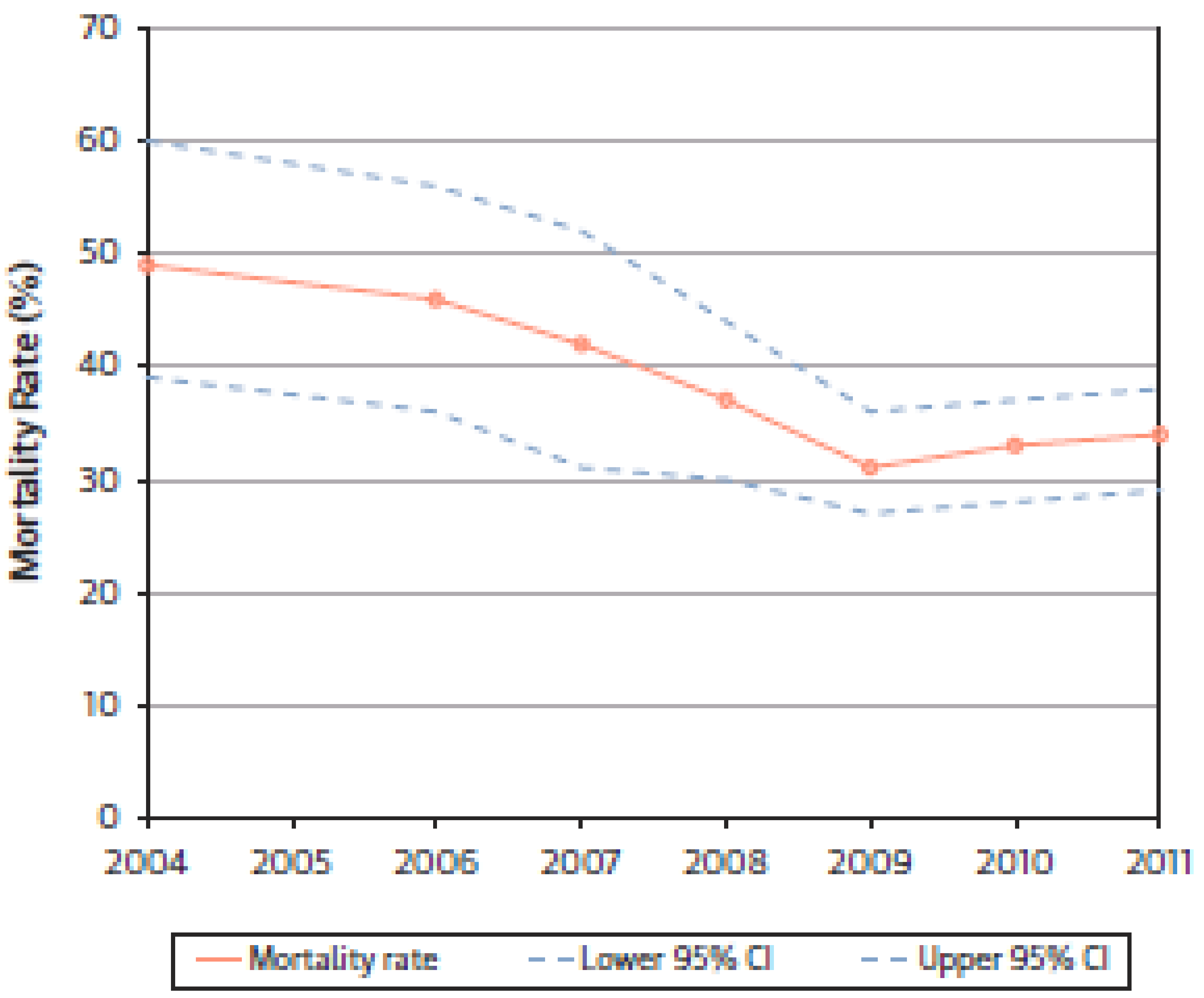
EACTS European Association For Cardio-Thoracic Surgery

Conflict of Interest

- **No Financial Disclosures**

National Trends in the Utilization of Short-Term Mechanical Circulatory Support (STCS)





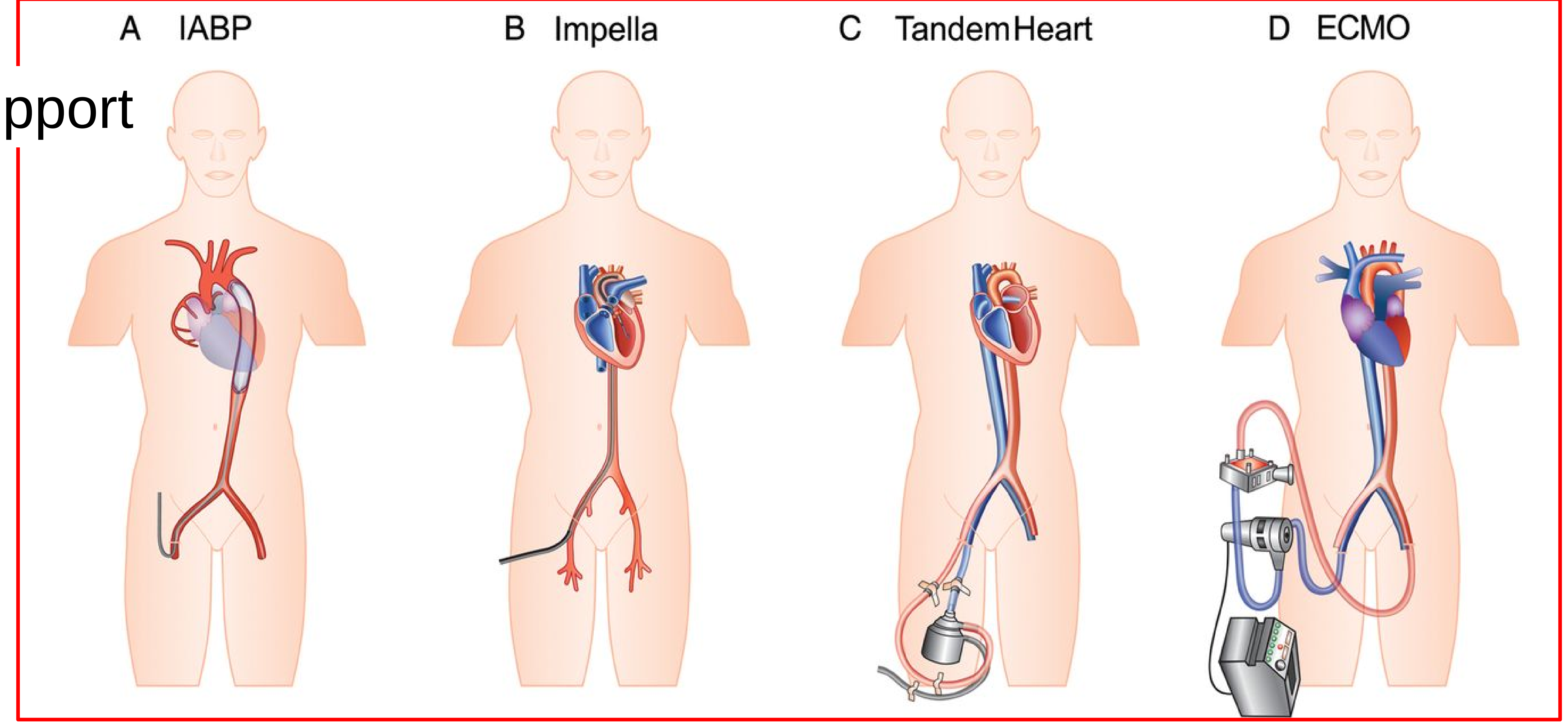
From 2007 to 2011, **use of percutaneous devices for short-term MCS increased by 1,511%** compared with a 101% increase in non-percutaneous devices.

CONCLUSIONS Use of short-term MCS in the United States has increased rapidly, whereas rates of in-hospital mortality have decreased. These changes have taken place in the context of declining hospital costs associated with short-term MCS. (J Am Coll Cardiol 2014;64:1407-15) © 2014 by the American College of Cardiology Foundation.

J Am Coll Cardiol 2014;64:1407–15

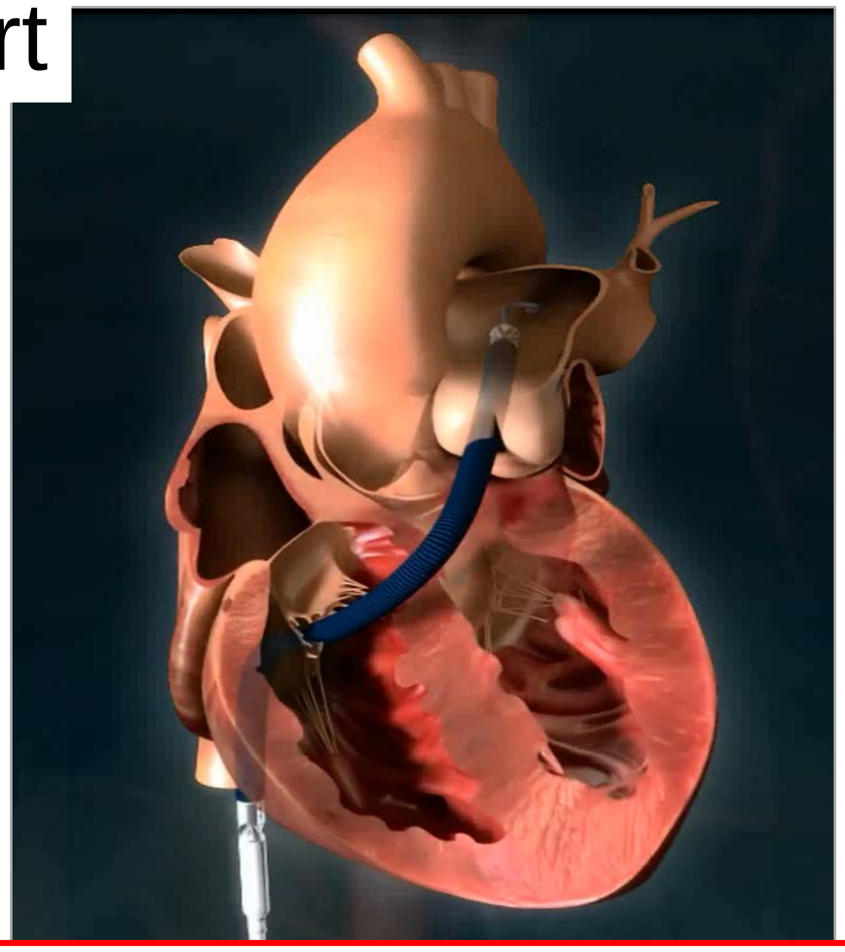
Percutaneous Temporary Support Options

LV Support

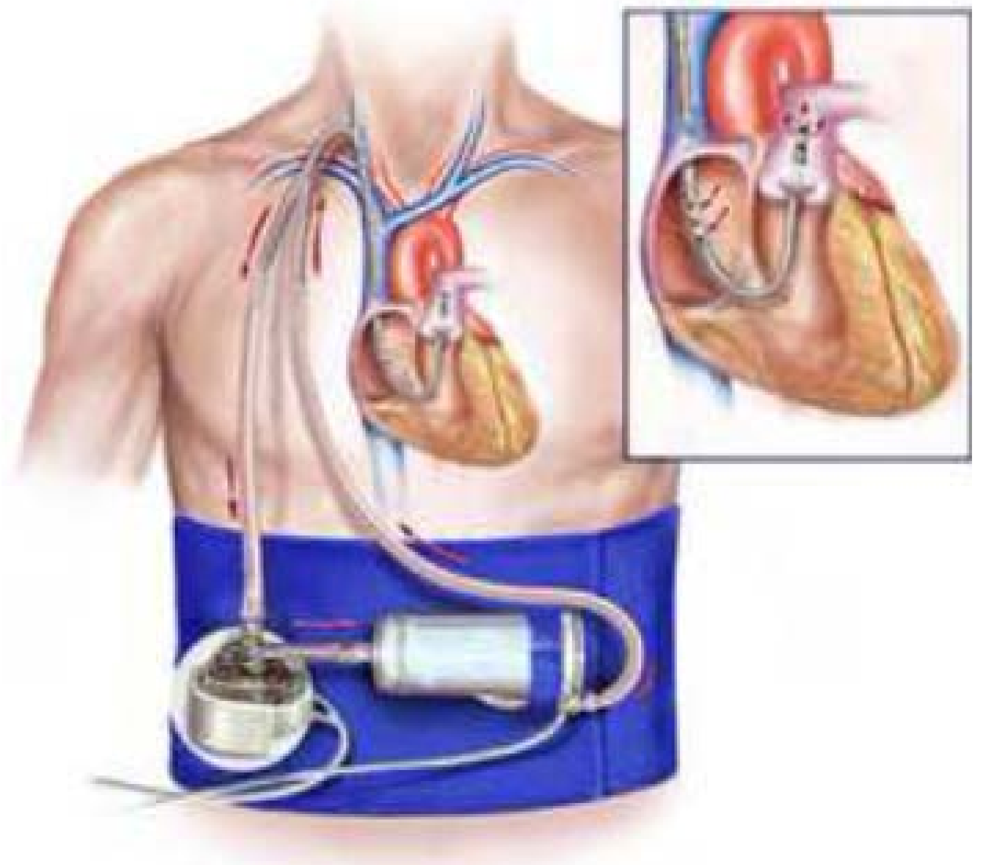


RV Support

Impella RP



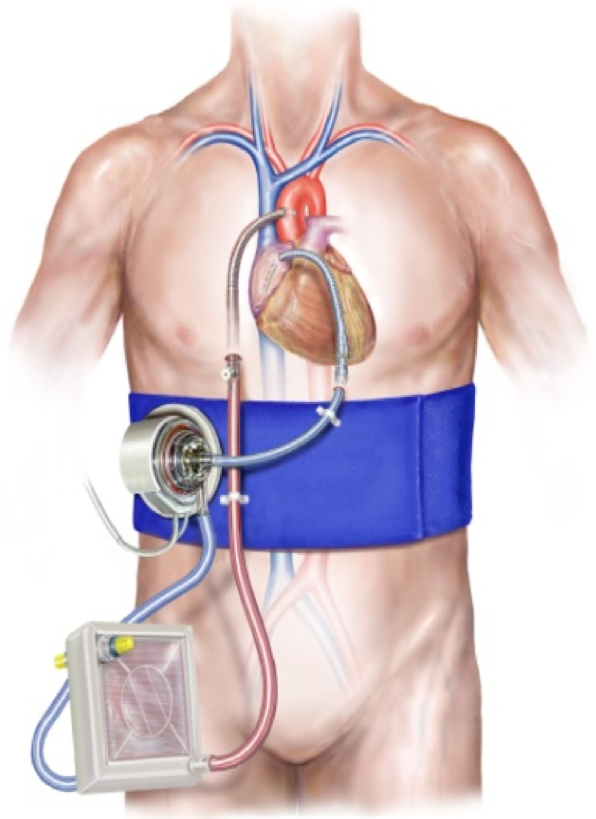
Tandem Heart-Protek-Duo



Surgical Temporary Mechanical Support Options

Sternotomy

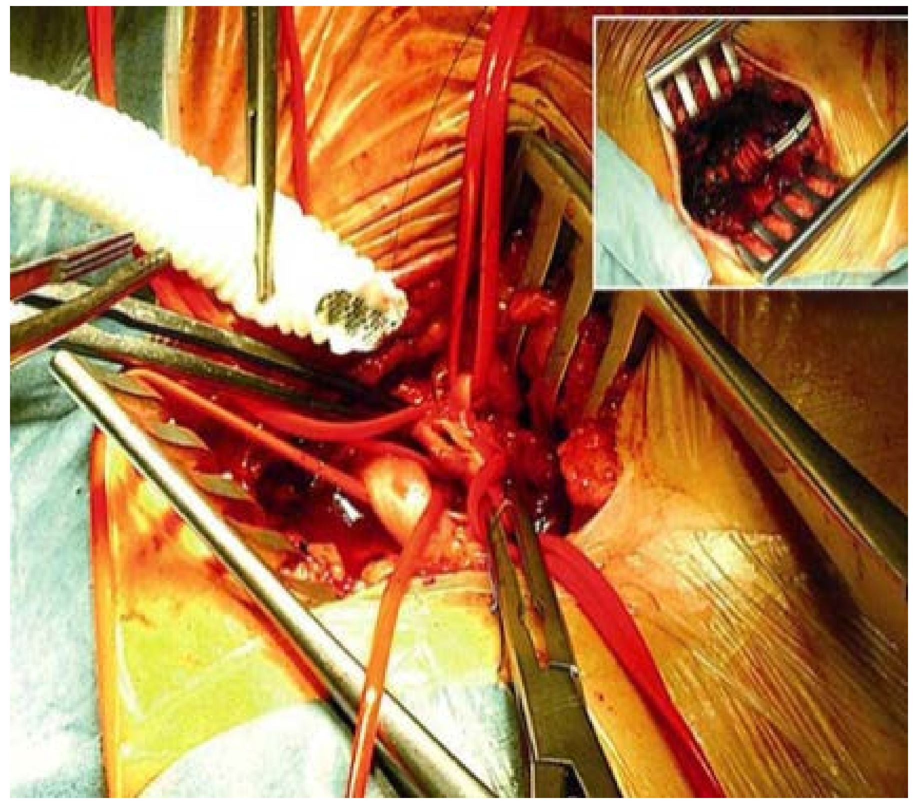
Centrimag



Central ECMO

Abiomed AB 5000

Thoratec PVAD



Goals of use TMCS in CS

- Circulatory Support
- Ventricular Support
- Coronary Perfusion
- Provide Time: to define treatment strategy

Temporary Devices Available and Characteristics

	TandemHeart LVAD –RVAD	**Impella 2.5-3.5 CP / RP**	**ECMO**	**Impella 5.0**	**Temp.VAD Surgical. (Centrimag)**
Bedside Implantation	No	No	Yes (No in CC)	No	No
Flow l/min	3-3.5	2.5-3.5	3-6	4-5	4-6
LV Unloading	Yes	Yes	Partially*** (YES in CC)	Yes	Yes
RV support	**YES***	**YES****	Yes	**YES****	Yes
Pulmonary support	No	No	Yes	No	no
Duration of support	Days-weeks?	Days-weeks?	< 2 weeks	Weeks	Months
Insertion	Percut.	Percut.	Percut.	Graft	Stern.
Cannula Size	17-21 Fr LVAD 29-31 Fr RVAD	9 Fr ,12-14F Sheath 22FR RP	15 Fr Arterial 22-25 Fr Ven.	9Fr, 21Fr Sheath	

* TH-Protek –Duo ** Impella RP *** Peripheral ECMO

2015 SCAI/ACC/HFSA/STS Clinical Expert Consensus Statement on the Use of Percutaneous Mechanical Circulatory Support Devices in Cardiovascular Care (Endorsed by the American Heart Association, the Cardiological Society of India, and Sociedad Latino Americana de Cardiologia Intervencion; Affirmation of Value by the Canadian As Interventional Cardiology—Association Ca Cardiologie d'intervention)*

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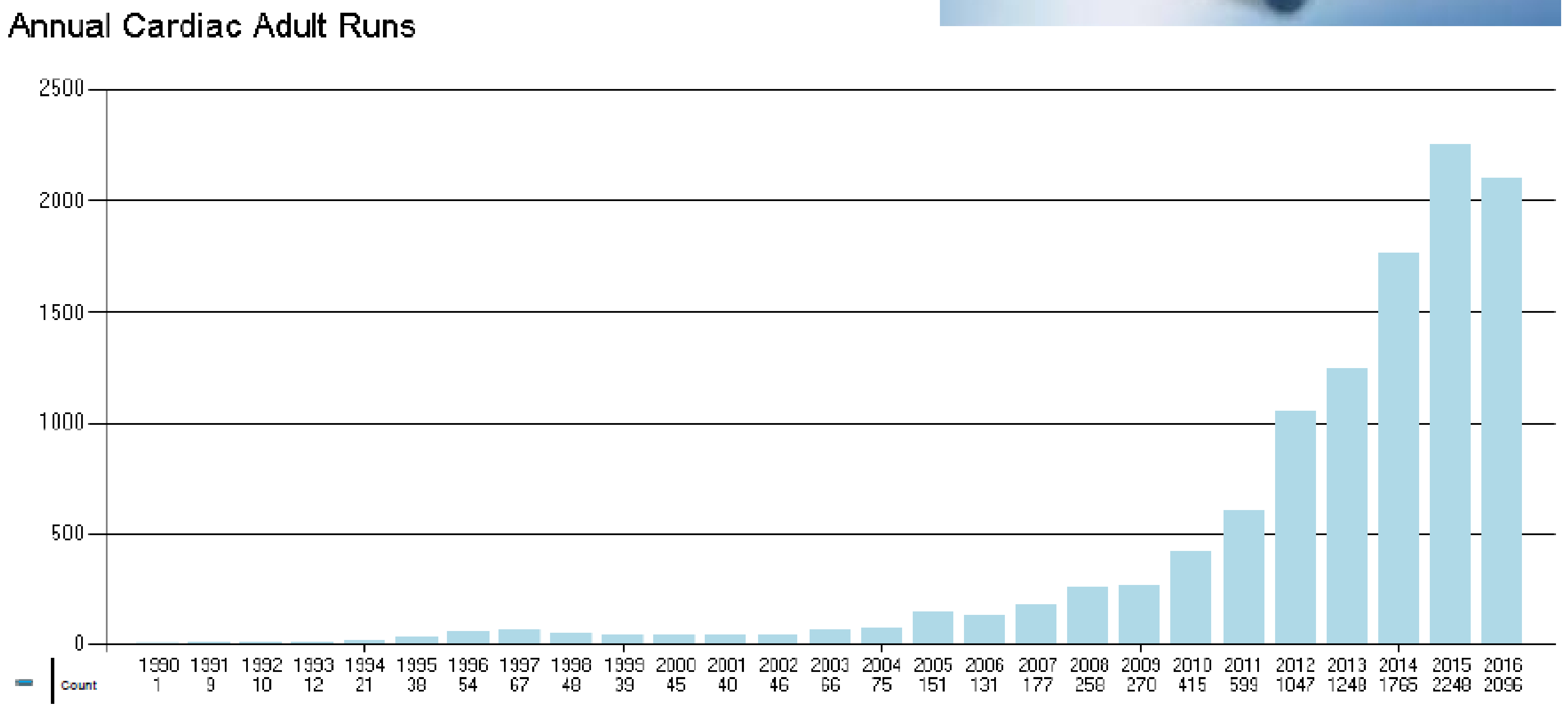
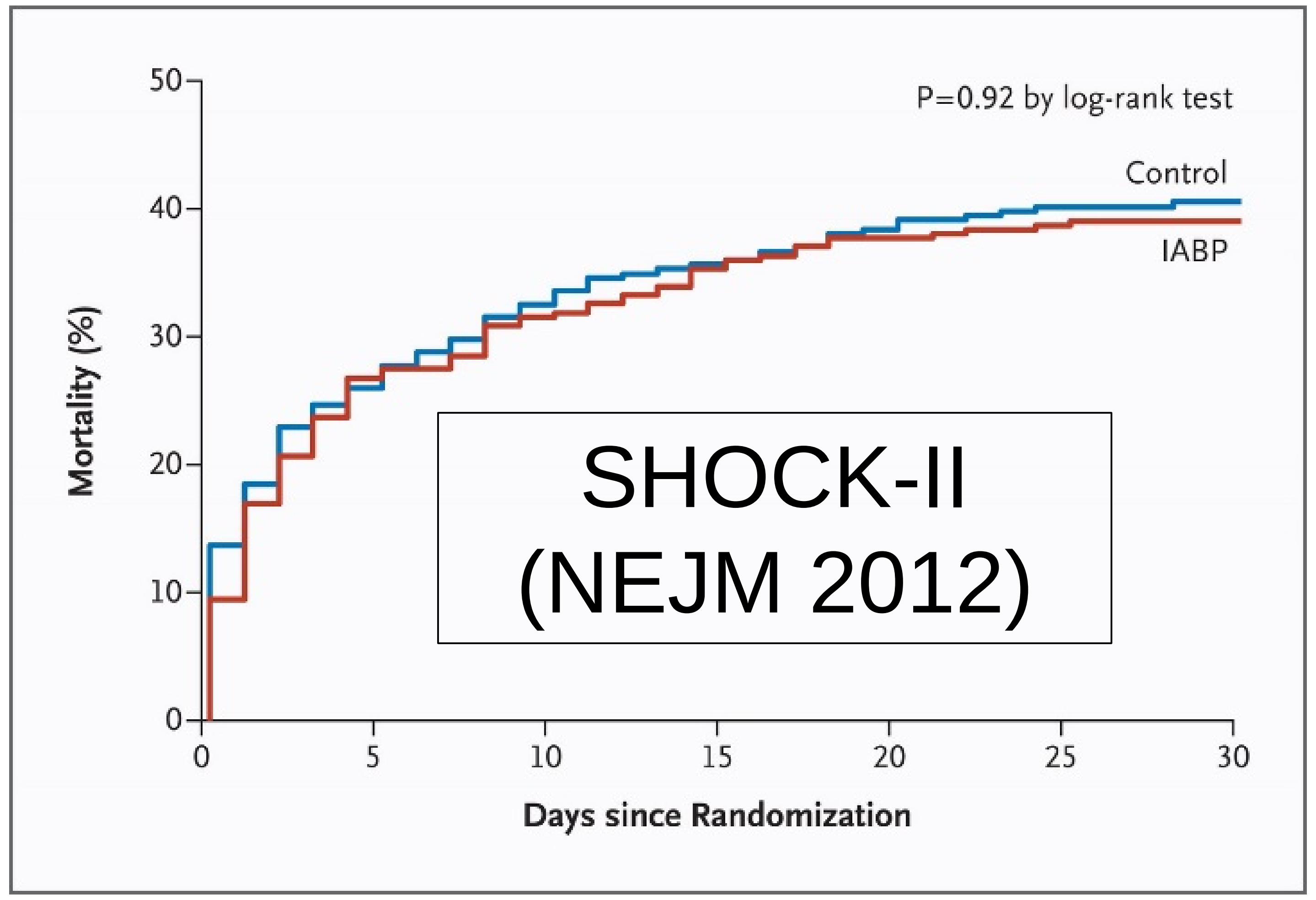
accompany vasopressor therapy. In patients with cardiogenic shock and mechanical complications, the TandemHeart or Impella 5.0 offers the greatest cardiac output and hemodynamic support while the individual is evaluated for surgery. Inotropes may still be required to support RV function after placement of a left-sided support device. Patients with biventricular failure and/or impaired oxygenation may require ECMO support. Biventricular support with two different devices (e.g., TandemHeart for RV support and Impella or IABP for LV support) has also been reported.

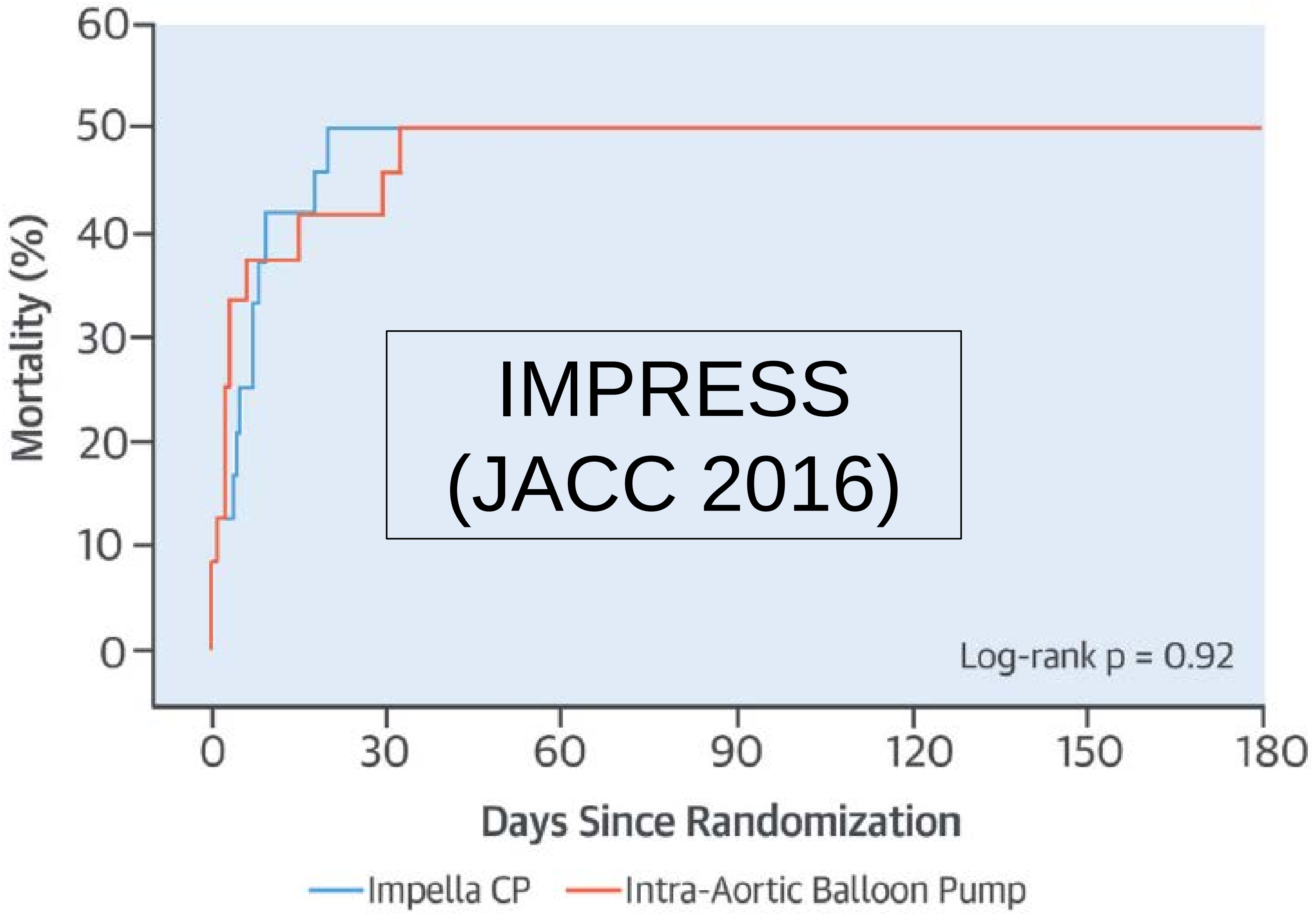
Table 1. Suggest

Indication	
Complications of AMI	Ischemic mitr is usually a primary PC can be treat
Severe heart failure in the setting of nonischemic cardiomyopathy	Examples incl cardiomyop cardiomyop to destinati
Acute cardiac allograft failure	Primary allograft failure (adult or pediatric) may be due to acute cellular or antibody-mediated rejection, prolonged ischemic time, or inadequate organ preservation.
Post-transplant RV failure	Acute RV failure has several potential causes, including recipient pulmonary hypertension, intraoperative injury/ischemia, and excess volume/blood product resuscitation. MCS support provides time for the donor right ventricle to recover function, often with the assistance of inotropic and pulmonary vasodilator therapy.[109]
Patients slow to wean from cardiopulmonary bypass following heart surgery	Although selected patients may be transitioned to a percutaneous system for additional weaning, this is rarely done.
Refractory arrhythmias	Patients can be treated with a percutaneous system that is somewhat independent of the cardiac rhythm. For recurrent, refractory, ventricular arrhythmias, ECMO may be required for biventricular failure.
Prophylactic use for high risk PCI	Particularly in patients with severe LV dysfunction (EF <20–30%) and complex coronary artery disease involving a large territory (sole-remaining vessel, left main or three vessel disease).[94,95,98]
High-risk or complex ablation of ventricular tachycardia	Similar to HR-PCI, complex VT ablation can be made feasible with percutaneous support. MCS use allows the patient to remain in VT longer during arrhythmia mapping without as much concern about systemic hypoperfusion.
High-risk percutaneous valve interventions	These evolving procedures may be aided with the use of MCSs.

VA ECMO : “Perfect storm” of timing and technology







Improvement in technology

Expanding indications for VA-ECMO, supported by observational data, case series

Cardiac

- ECPR*
- Post-cardiotomy
- Myocarditis
- AMI, bridge to PCI, cardiac surgery
- High-risk EP ablations
- Pulmonary vascular
- Bridge to LVAD, in combination with LVAD, OHTx transplant

Critical Illness

- Overdose
- Trauma
- Septic shock
- Peri-partum complications, support to term delivery
- Organ donation after cardiac death

Chen, Lancet 2008; Kagawa, Circulation 2012; Arlt, Eur J Cardiothorac Surg 2012; Haneya, Eur J Cardiothorac Surg 2012; Haneya, Perfusion 2012; Magliocca, J Trauma 2005

ECMO for Treatment of Cardiogenic Shock and Cardiac Arrest: A Meta-Analysis of 1,866 Adult Patients

Cohort studies!

Study	Number of Patients	Patient Type	Average Age (y)	Age Range (y)	Males (%)	Peripheral ECMO (n, %)	IABP (n, %)	Average Time on ECMO (h)	Survival to D/C (n, %)	Bridged to VAD (n, %)/Survival to D/C (n, %)	Bridged to HTP (n, %)/Survival to D/C (n, %)
Bakhtiary et al [1]	45	PCCS	60.1 ± 13.6	Adults	78	29 (64)	30 (67)	153.6	13 (28.9)	5 (11.1)/3 (60)	2 (4.4)/1 (50)
Belle et al [20]	51	Mixed	51 ± 15	≥18	75	51 (100)	5 (10)	–	14 (27.5)	–	–
Bermudez et al [9]	42	Mixed	53.5	28–80	83	37 (88)	37 (88)	67.1	–	22 (52.4)/–	–
Elsharkawy et al [2]	233	PCCS	57	Adults	67	156 (67)	22 (9.4)	–	84 (36.1)	–	–
Hei et al [19]	68	PCCS	49.2 ± 13.3	≥18	76	67 (99)	11 (16)	114.6	43 (63.2)	–	8 (11.8)/6 (75)
Hsu et al [3]	51	PCCS	63 ± 15.7	Adults	71	51 (100)	–	180	17 (33.3)	–	3 (5.9)/3 (100)
Kagawa et al [21]	77	CA	61.9	18–74	71	77 (100)	52 (68)	–	16 (20.8)	4 (5.2)/–	–
Kim et al [10]	27	AMI	63.7 ± 11	45–81	59	27 (100)	2 (7)	30.2	16 (59.3)	–	–
Loforte et al [17]	73	Mixed	60.3 ± 11.6	23–84	75	73 (100)	73 (100)	261.6	33 (45.2)	3 (4.1)/2 (66.7)	0 (0)/N/A
Moraca et al [22]	26	Mixed	57	18–76	69	24 (92)	21 (80)	72	17 (65.4)	9 (34.6)/6 (66.7)	1 (3.8)/1 (100)
Pagani et al [11]	33	Mixed	47 ± 11	Adults	70	22 (67)	20 (61)	65	12 (36.4)	10 (30.3)/8 (80)	7 (21.2)/7 (100)
Rastan et al [4]	517	PCCS	63.5 ± 11.2	18–84	72	141 (27)	383 (74)	78.7	128 (24.8)	15 (2.9)/3 (20)	5 (1)/2 (40)
Schmidt et al [27]	220	Mixed	49 ± 16	Adults	67	–	–	320.9	–	–	–
Slottosch et al [23]	77	Mixed	60 ± 13	25–83	77	–	72 (94)	79	–	–	–
Smith et al [24]	17	PCCS	66.6 ± 13.6	37–83	76	11 (65)	14 (82)	86	7 (41.2)	–	–
Unosawa et al [25]	47	PCCS	64.4 ± 12.5	22–83	74	32 (68)	39 (83)	63.5	14 (29.8)	–	–
Wang et al [5]	62	PCCS	51 ± 15	Adults	52	–	19 (31)	61	34 (54.8)	–	–
Wu et al [6]	110	PCCS	60 ± 14	Adults	71	–	–	143.3	46 (41.8)	–	–
Wu et al [13]	60	Mixed	51.33	19–83	67	–	44 (73)	97.3	32 (53.3)	–	3 (5)/2 (66.7)
Zhang et al [7]	32	PCCS	55.4 ± 11.9	30–75	56	17 (53)	–	64.8	8 (25.0)	–	–

- **Survival to D/C 25-65%**
- **Need of a durable VAD 5-35%**
- **Bridge to Heart TX 4-21%**

Cheng et al . Ann Thorac Surg 2014;97:610–6

Veno–Arterial (VA) ECMO for ECPR

- **Cardiac arrest in acute reversible diseases*** **(referenced from the 2015 AHA guidelines)**

***Inclusion criteria for Extra-corporeal cardiopulmonary resuscitation (ECPR):** acute reversible disease (intoxication, hypothermia) and pathology correctable by angioplasty, surgery or transplantation

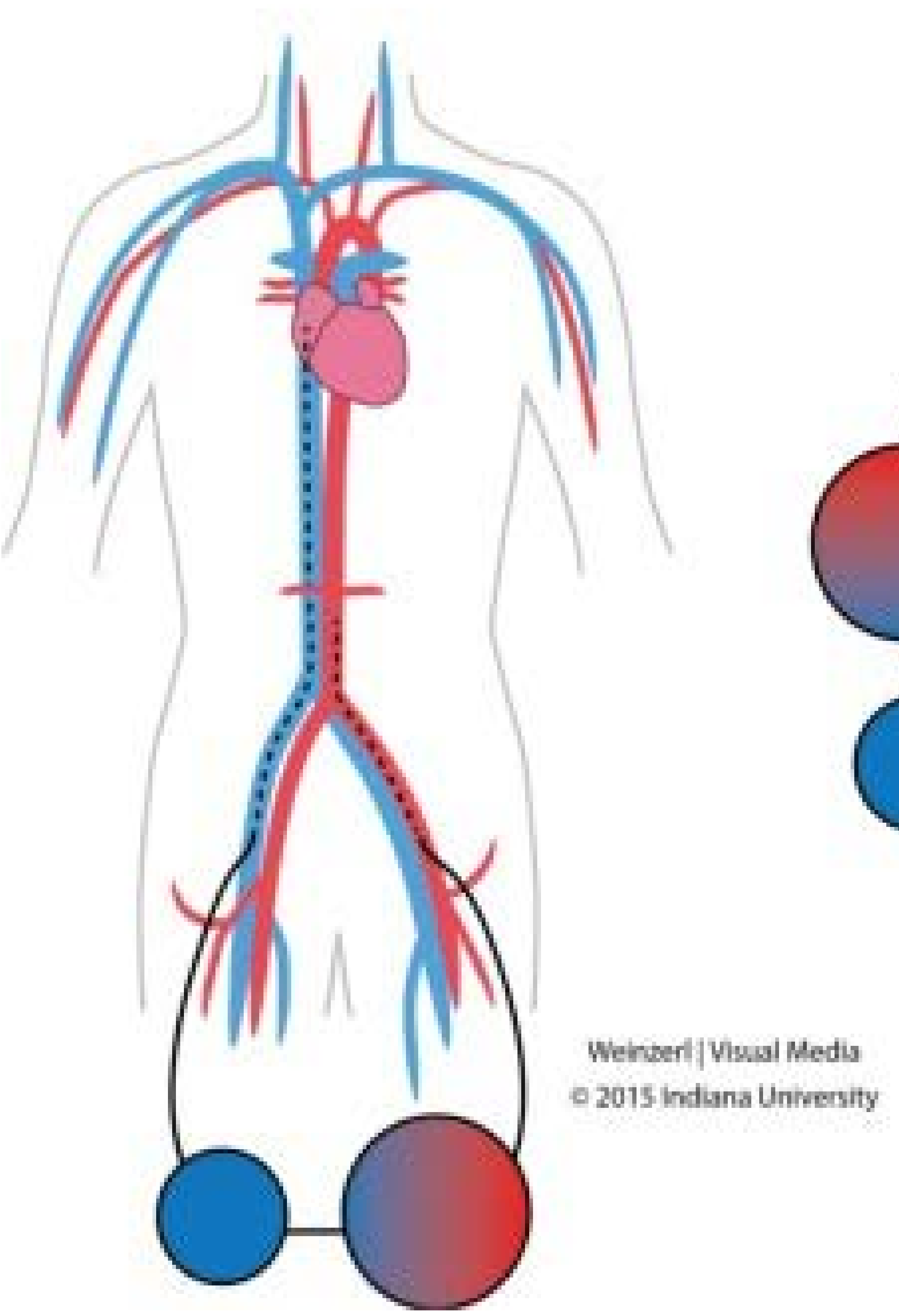
  - Age < 75 with cardiac arrest
  - Cardiac arrest/CPR with less than 60 min of resuscitation with high quality CPR
  - Witnessed arrest in patients who have not had ROSC within 20 min of CPR
  - No flow cardiac arrest less than 5 min
  - EtCO2 more than 10 mmHg after 20 min of CPR

- **Do not forget standard ECMO Contraindications**

  - Disseminated malignancy (<1y. survival)
  - Known severe brain injury, e.g. traumatic brain injury with bleed
  - Unrepaired aortic dissection
  - Severe aortic regurgitation
  - Severe chronic organ dysfunction (emphysema, cirrhosis, renal failure)
  - Compliance (financial, cognitive, psychiatric, or social)

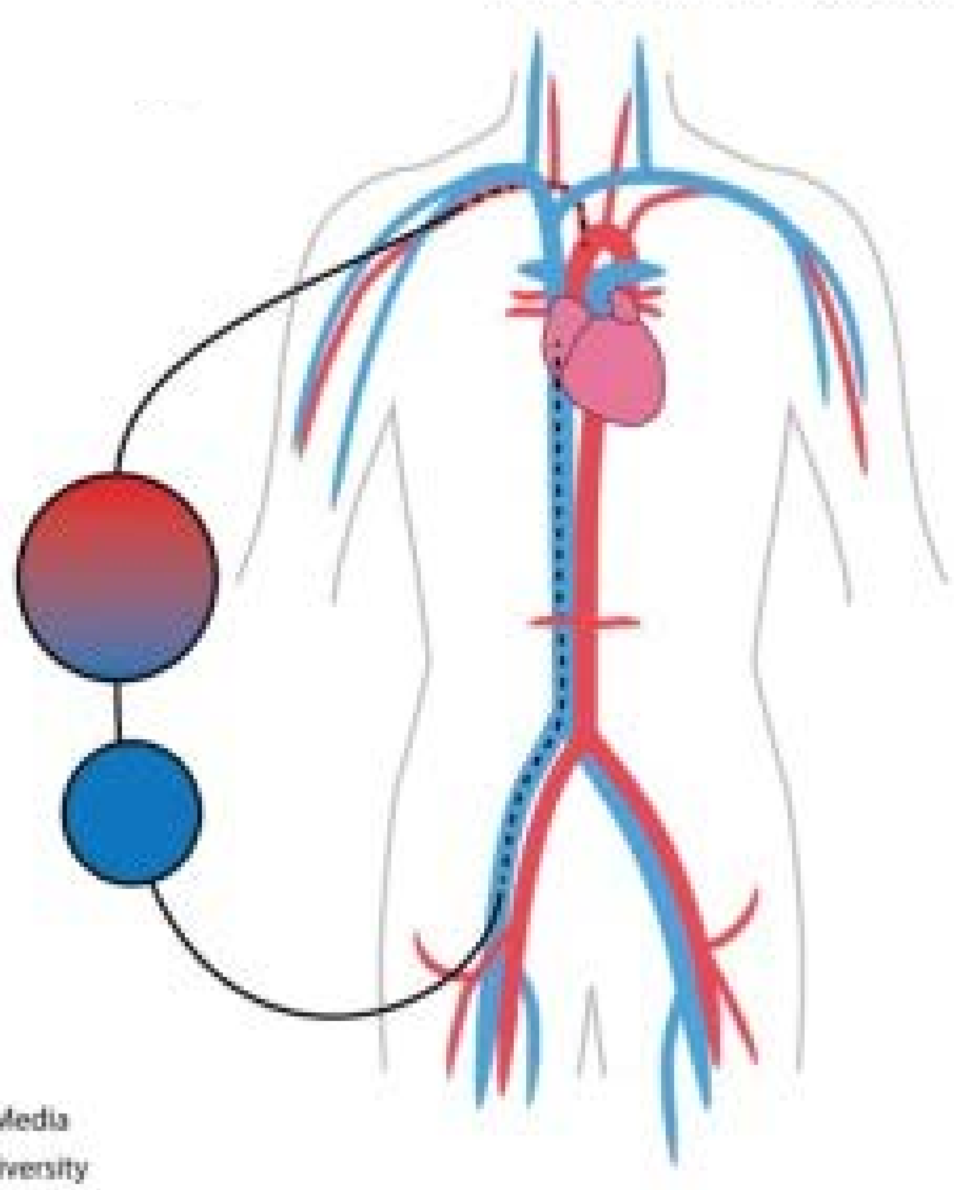
Cannulation Strategies for VA ECMO

Femoral – Femoral



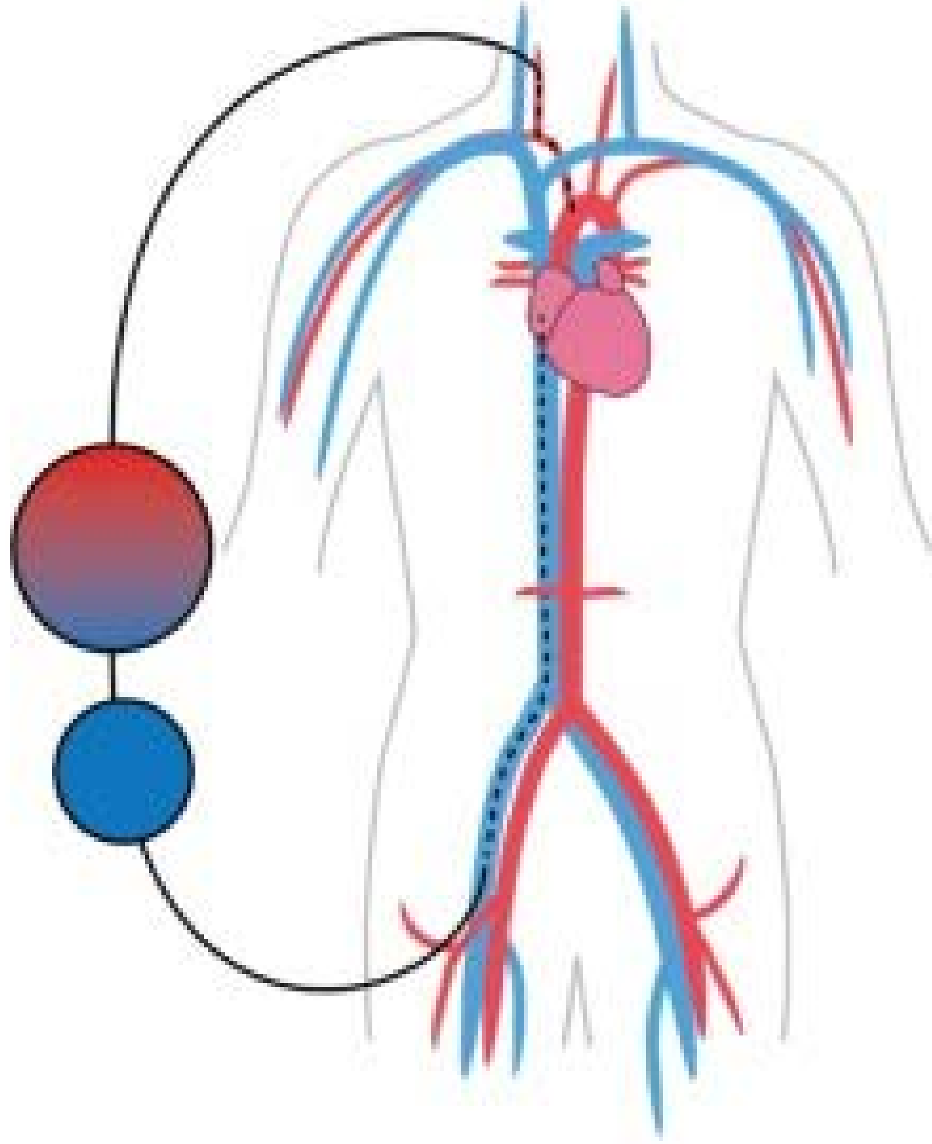
- Rapid initiation of support

Axillary – Femoral



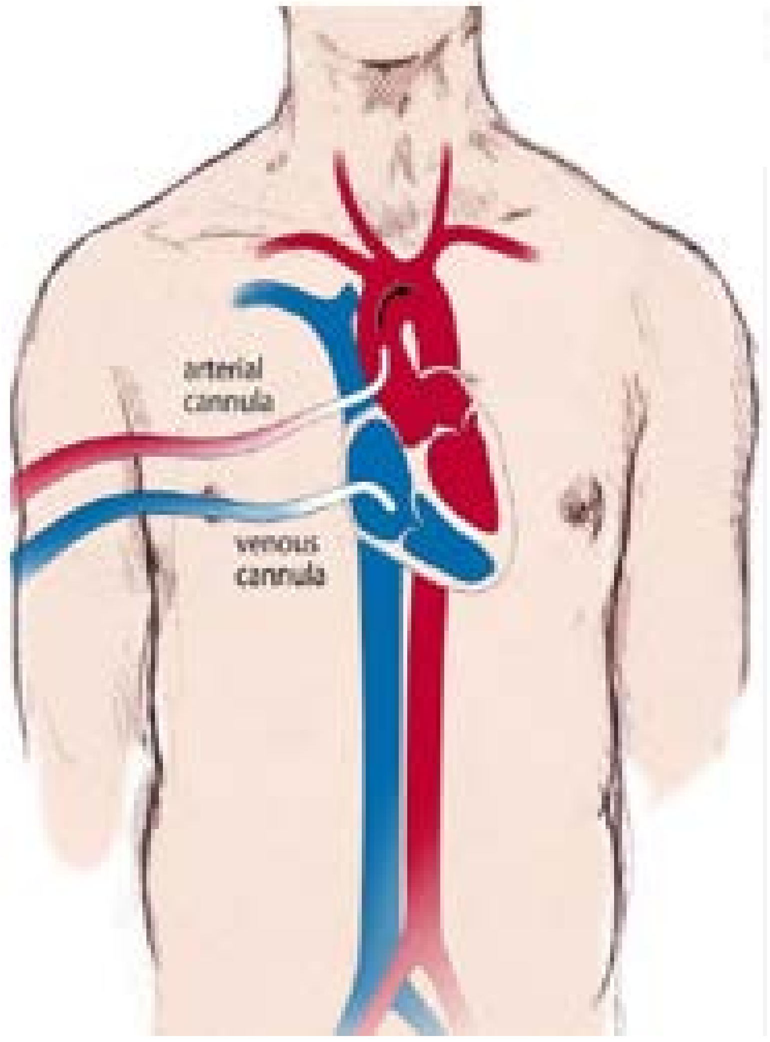
- Reduces risk of cerebral hypoxia
- Advantages in patients with PAD

Carotid – Femoral



- Pediatric application

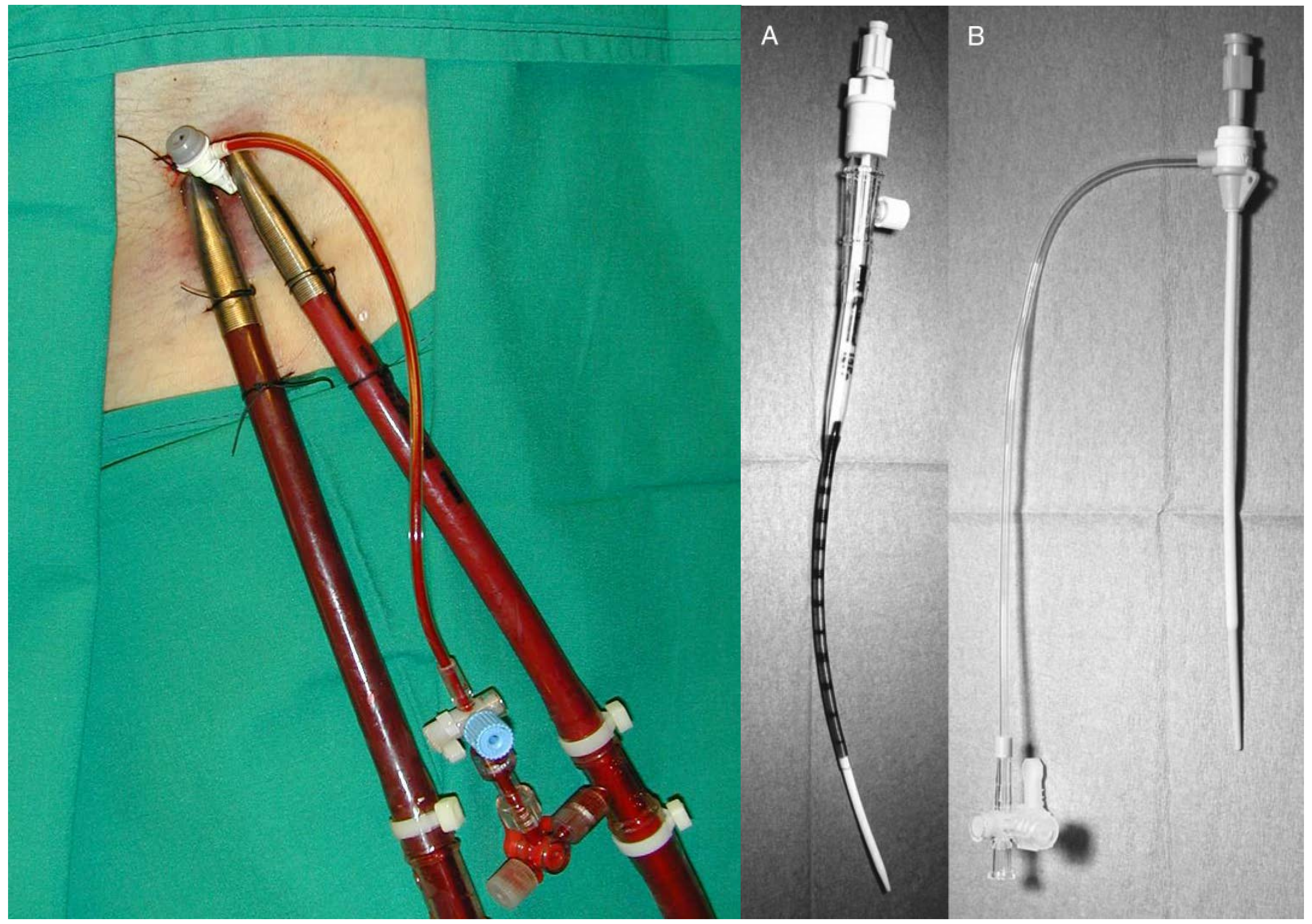
Central AO-RA



- Frequently used in post-cardiotomy failure
- Superior Drainage

Makdisi G, Wang I. J Thoracic Dis. 2015

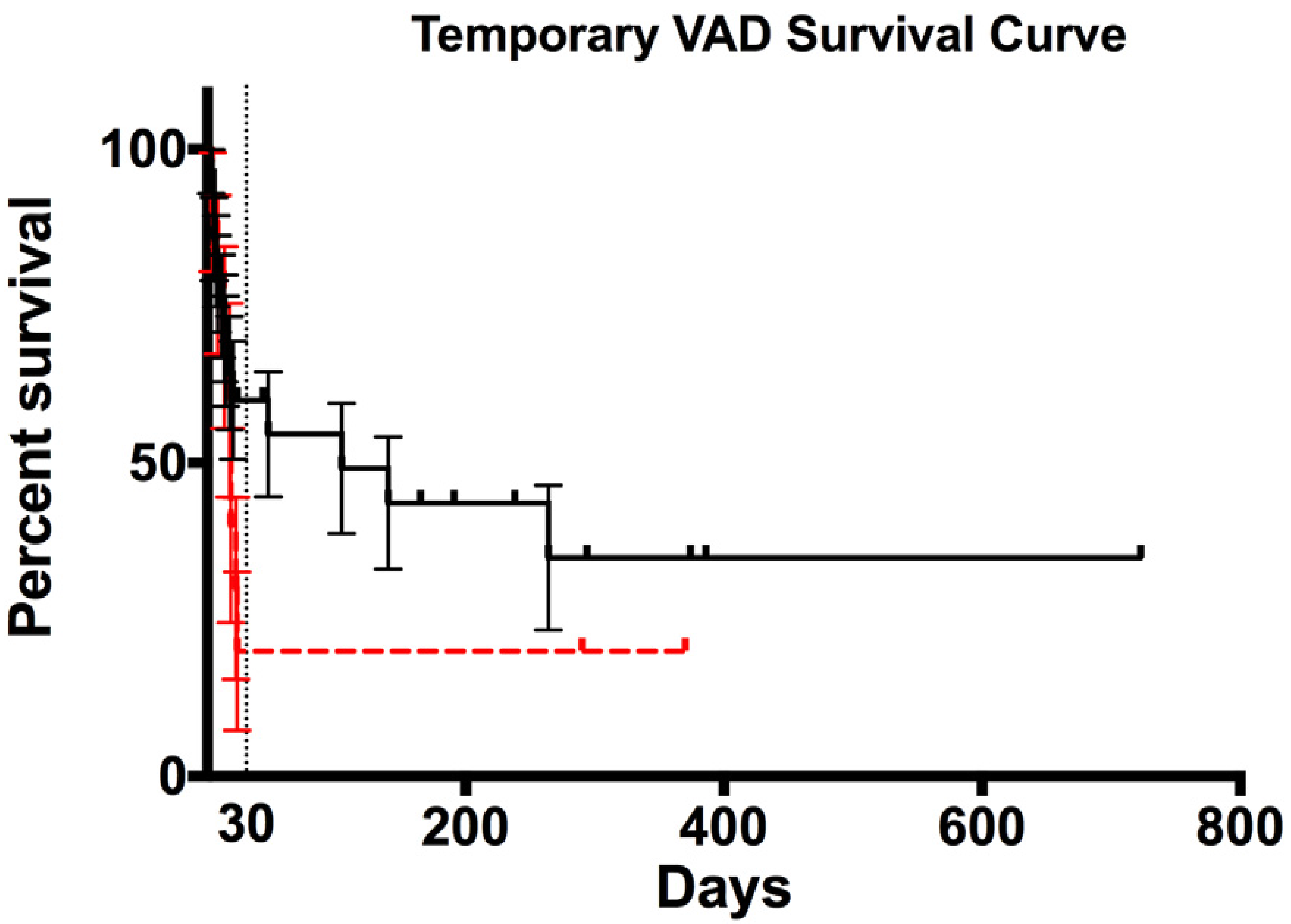
VA ECMO Distal Perfusion to Minimize Vascular Complications.



- **Distal LE perfusion decreases vascular complications**

The incidences of limb ischemia and limb ischemia requiring surgical intervention were significantly higher for the introducer sheath compared with the cannula (30.6 vs. 15.6% and 15.4 vs. 6.25%, respectively).

Artificial Organs 2014, 38(11):940–944

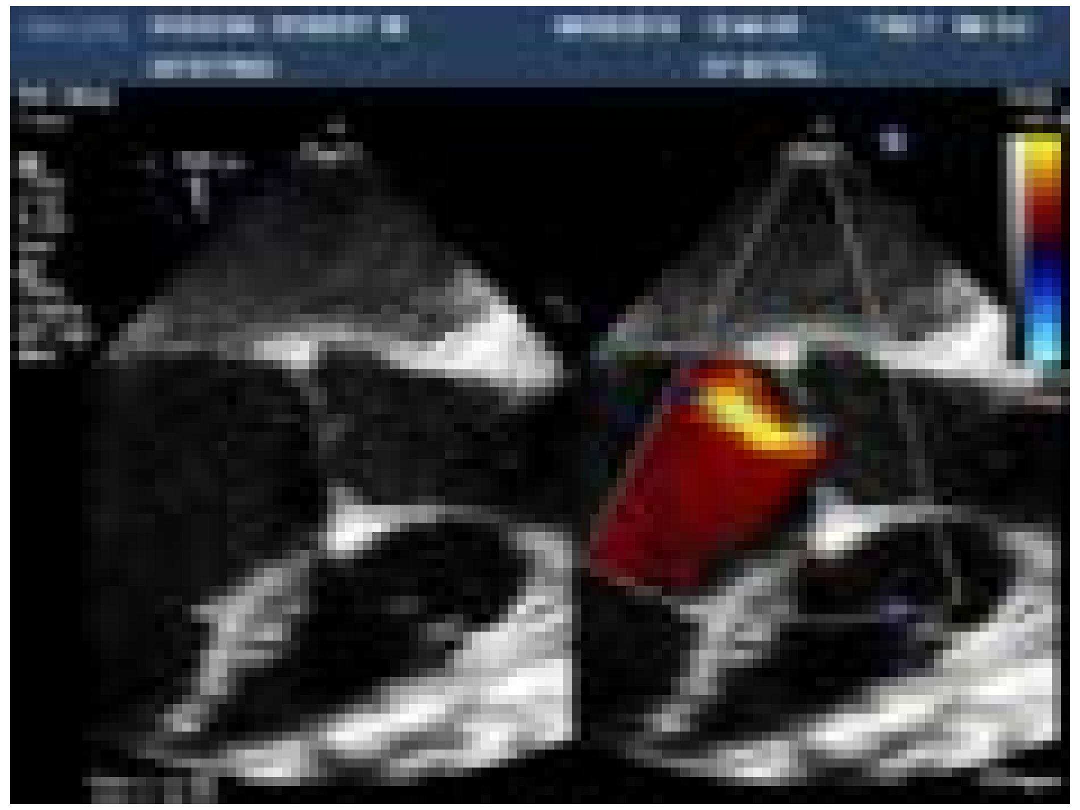


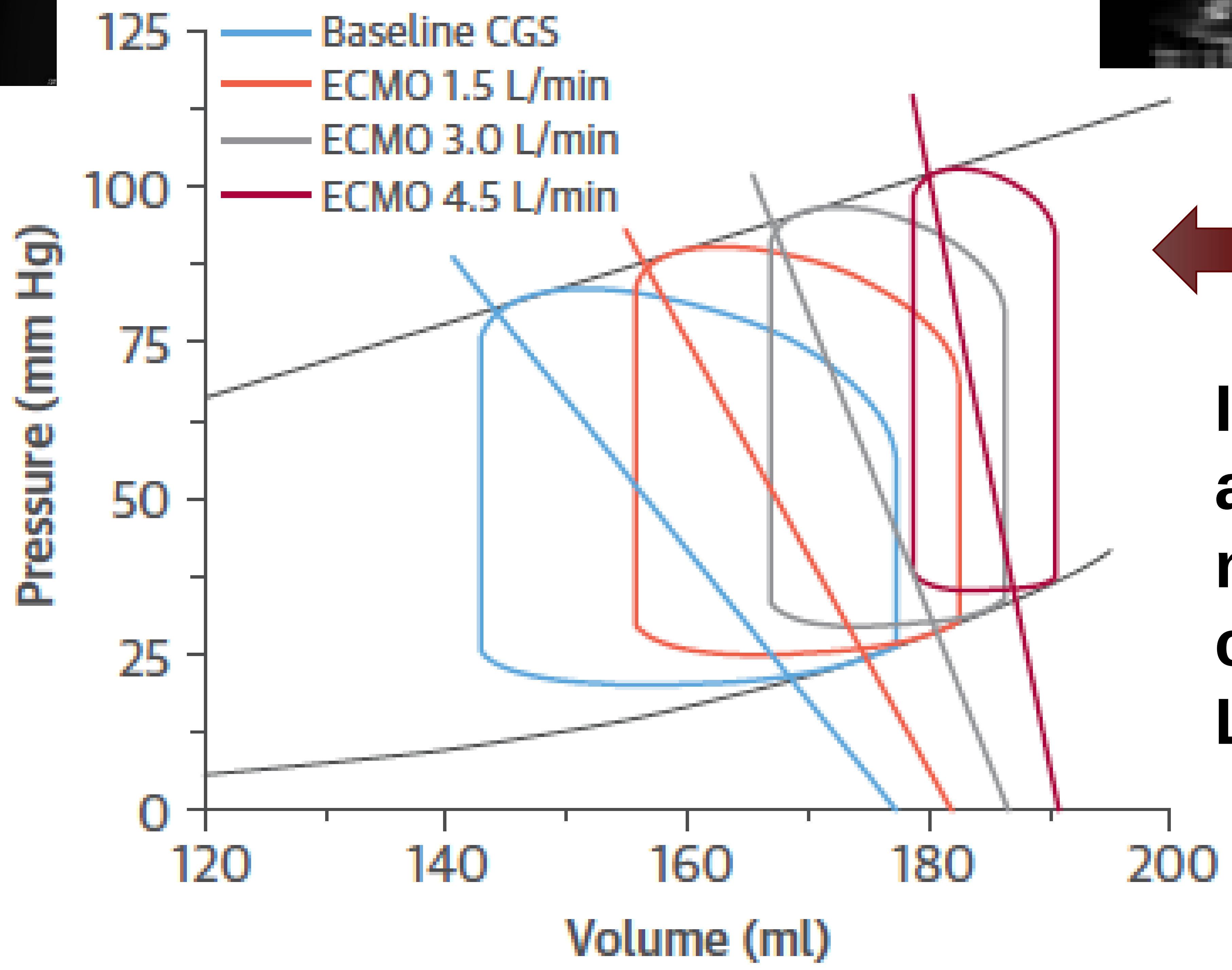
Number at Risk				
Non-EVC	13	7	2	1
EVC	3	3	1	1

EVCs result in higher 30-day mortality, more frequent withdrawal of care, and shortened survival time relative

J Vasc Surg 2014;59:1622-7

Hemodynamic Effects of Peripheral VA-ECMO





Increased afterload reduces native CO and causes increase in LVEDP and LVEDV

Burkhoff et al. J Am Coll Cardiol 2015;66:2663–74

Consequences of Inadequate LV Unloading During VA-ECMO

Inadequate residual native cardiac output leads to:

- **Stagnant areas of blood flow in the left ventricle**
  - Risk of LV thrombus
  - Impair ability to recover if LV full of thrombus
- **Stagnant areas of blood flow in the aortic root and ascending aorta**
  - Aortic root thrombus
- **LV distension and pulmonary hypertension**
  - Risk of pulmonary hemorrhage

Concomitant implantation of Impella® on top of veno-arterial extracorporeal membrane oxygenation may improve survival of patients with cardiogenic shock.

Prospective match cohort

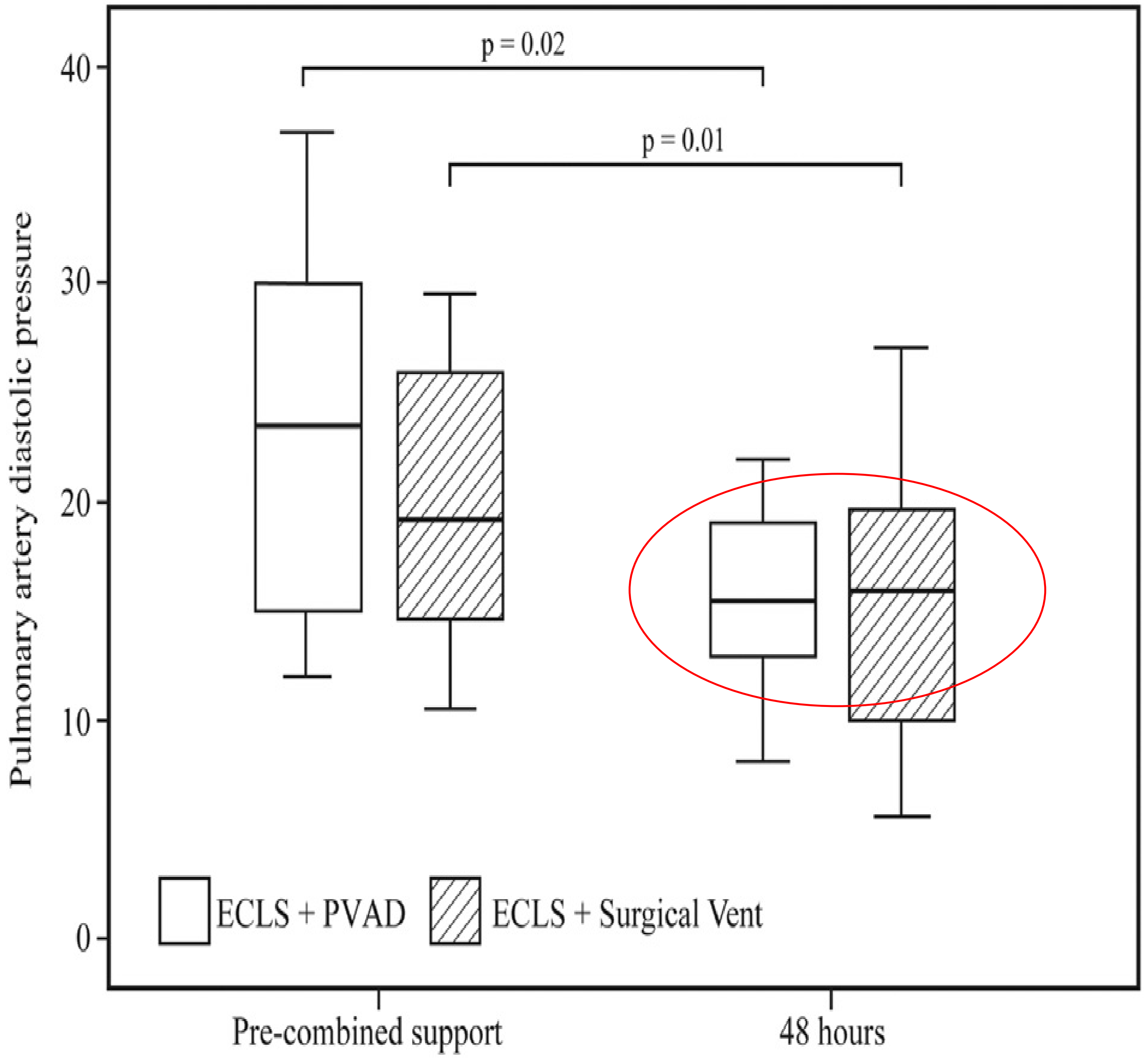
Parameter	Total ($n = 63$)	ECMO + Impella ($n = 21$)	ECMO ($n = 42$)	P-value
Age, years	53 (46–65)	51 (47–61)	54.5 (46–65)	0.6
Males, *n* (%)	55 (87)	18 (86)	37 (88)	0.5
CPR, *n* (%)	40 (63)	12 (57)	28 (67)	0.5
STEMI, *n* (%)	30 (48)	10 (48)	20 (48)	1
PCI, *n* (%)	27 (43)	9 (43)	18 (43)	1
pH	7.27 (7.00–7.41)	7.31 (7.08–7.39)	7.27 (6.98–7.43)	0.7
Lactates, mmol/L	9.02 (4.05–14.17)	9.02 (4.60–11.00)	9.03 (4.05–14.17)	1
Concomitant IABP, *n* (%)	13 (21)	6 (29)	7 (17)	0.3

Parameter	Total ($n = 63$)	ECMO + Impella ($n = 21$)	ECMO ($n = 42$)	P-value
Hospital mortality, *n* (%)	41 (65)	10 (48)	31 (74)	0.04
Bridge to next therapy or recovery, *n* (%)	28 (44)	13 (62)	15 (36)	0.048
Weaning from MCS, *n* (%)	26 (41)	10 (48)	16 (28)	0.047
Bridge to recovery, *n* (%)	19 (30)	8 (38)	11 (26)	0.3
Bridge to VAD, *n* (%)	8 (13)	4 (19)	4 (9.5)	0.5
Bridge to cardiac transplantation, *n* (%)	0	0	0	
Duration of ECMO, h	120 (36–234)	148 (72–239)	73.5 (29–217)	0.2
Duration of MV, h	93 (29–228)	163 (90–228)	48 (17–265)	0.04
CVVH, *n* (%)	18 (29)	10 (48)	8 (19)	0.02
Haemolysis, *n* (%)	30 (48)	16 (76)	14 (33)	0.004
Major bleeding, *n* (%)	20 (32)	8 (38)	12 (29)	0.6
Minor bleeding, *n* (%)	14 (22)	4 (19)	10 (24)	0.8
LVEF at weaning, %	45.5 (30–55)	52.5 (47–55.5)	37.5 (25–50)	0.13

Concomitant treatment with VA-ECMO and Impella may improve outcome in patients with cardiogenic shock compared with VA-ECMO only.

Pappalardo et al European Journal of Heart Failure (2016) doi:10.1002/

Left Ventricular Unloading by Impella Device Versus Surgical Vent During Extracorporeal Life Support



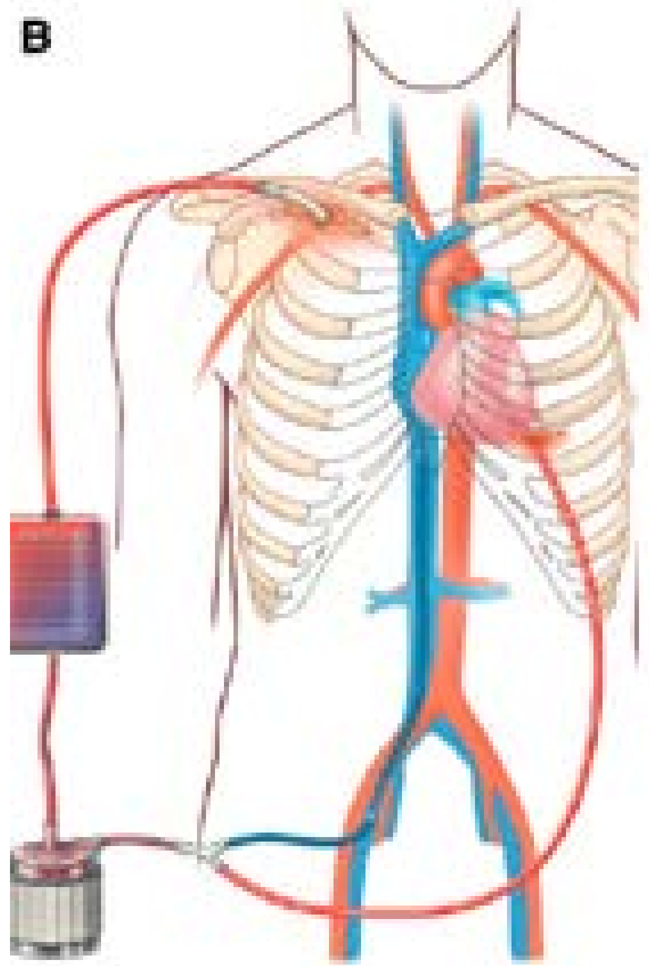


Table 4. Inhospital Outcomes and Complications

Variable	ECLS + PVAD (n = 23) No. (%)	ECLS + Surgical Vent (n = 22) No. (%)	*p* Value
Survival			
48 hours	20 (87)	21 (95)	0.61
30 days	10 (43)	7 (32)	0.42
ICU discharge	8 (35)	5 (23)	0.37
ECLS decannulation	7 (30)	6 (27)	0.82
Bridged to LVAD	6 (26)	4 (18)	0.52
Cause of death			
Bleeding	1 (4)	1 (5)	0.99
Cardiac death	4 (17)	8 (36)	0.19
Infection	1 (4)	2 (9)	0.61
Multiple system organ failure	8 (35)	5 (23)	0.37
Stroke	1 (4)	1 (5)	0.99
Vascular complications			
Bleeding	9 (39)	10 (45)	0.67
Hemolysis	5 (22)	1 (5)	0.19
Hypoperfusion/limb ischemia	3 (13)	4 (18)	0.70
Initial ECLS mode			
Central	7 (30)	20 (91)	<0.001
Peripheral	16 (70)	2 (9)	<0.001
Impella[a] PVAD model			
2.5	7 (30)	...	...
CP	7 (30)	...	...
5.0	9 (39)	...	...
Surgical vent route			
Left ventricular apex	...	10 (45)	...
Left atrium	...	9 (41)	...
Pulmonary artery	...	3 (14)	...

PVAD use in ECLS patients is an effective means of LV unloading and preventing worsened pulmonary edema, with outcomes and complications that are comparable to surgical LV vent.

Ann Thorac Surg 2017;104:861–7)

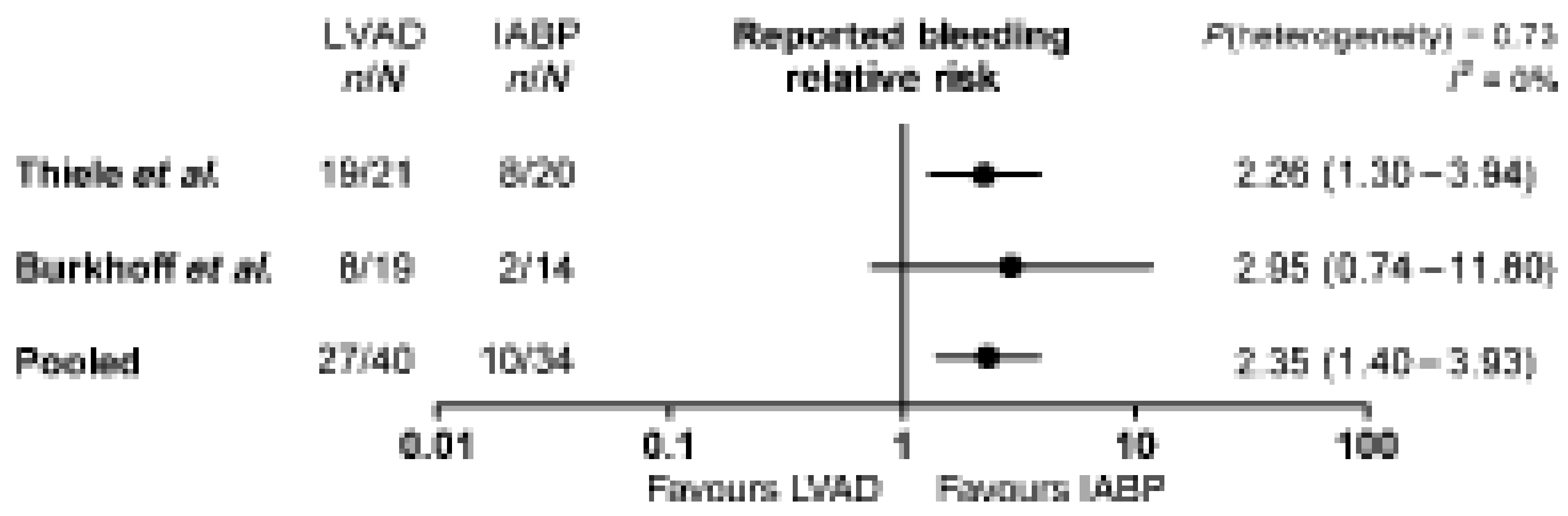
Other Devices:

- Impella
- Tandem Heart
- Centrimag

Percutaneous left ventricular assist devices vs. IABP for treatment of cardiogenic shock: a meta-analysis of controlled trials

Tandem Heart **Impella 2.5**

	Thiele et al.[16]		Burkhoff et al.[17]		Seyfarth et al.[18]		Pooled (fixed effect model)	
	LVAD (n = 21)	IABP (n = 20)	LVAD (n = 19)	IABP (n = 14)	LVAD (n = 13)	IABP (n = 13)	Mean difference/ relative risk	P-value
Haemodynamics								
CI ± SD (L/min/m²)	2.3 ± 0.6	1.8 ± 0.4	2.2 ± 0.6	2.1 ± 0.2	2.2 ± 0.6	1.8 ± 0.7	0.35 (0.14; 0.55)	<0.001
MAP ± SD (mmHg)	76 ± 10	70 ± 16	91 ± 16	72 ± 12	87 ± 18	71 ± 22	12.1 (6.3; 17.9)	<0.001
PCWP ± SD (mmHg)	16 ± 5	22 ± 7	16 ± 4	25 ± 3	19 ± 5	20 ± 6	−6.2 (−8.0; −4.3)	<0.001
Clinical outcome								
30-day mortality, n (%)	9 (43)	9 (45)	9 (47)	5 (36)	6 (46)	6 (46)	1.06 (0.68; 1.66)	0.80
Reported adverse events								
Leg ischaemia, n (%)	7 (33)	0 (0)	4 (21)	2 (14)	1 (8)	0 (0)	2.59 (0.75; 8.97)	0.13
Bleeding, n (%)	19 (90)	8 (40)	8 (42)	2 (14)			2.35 (1.40; 3.93)	<0.01
Fever of sepsis, n (%)	17 (81)	10 (50)	4 (21)	5 (36)			1.38 (0.88; 2.15)	0.16



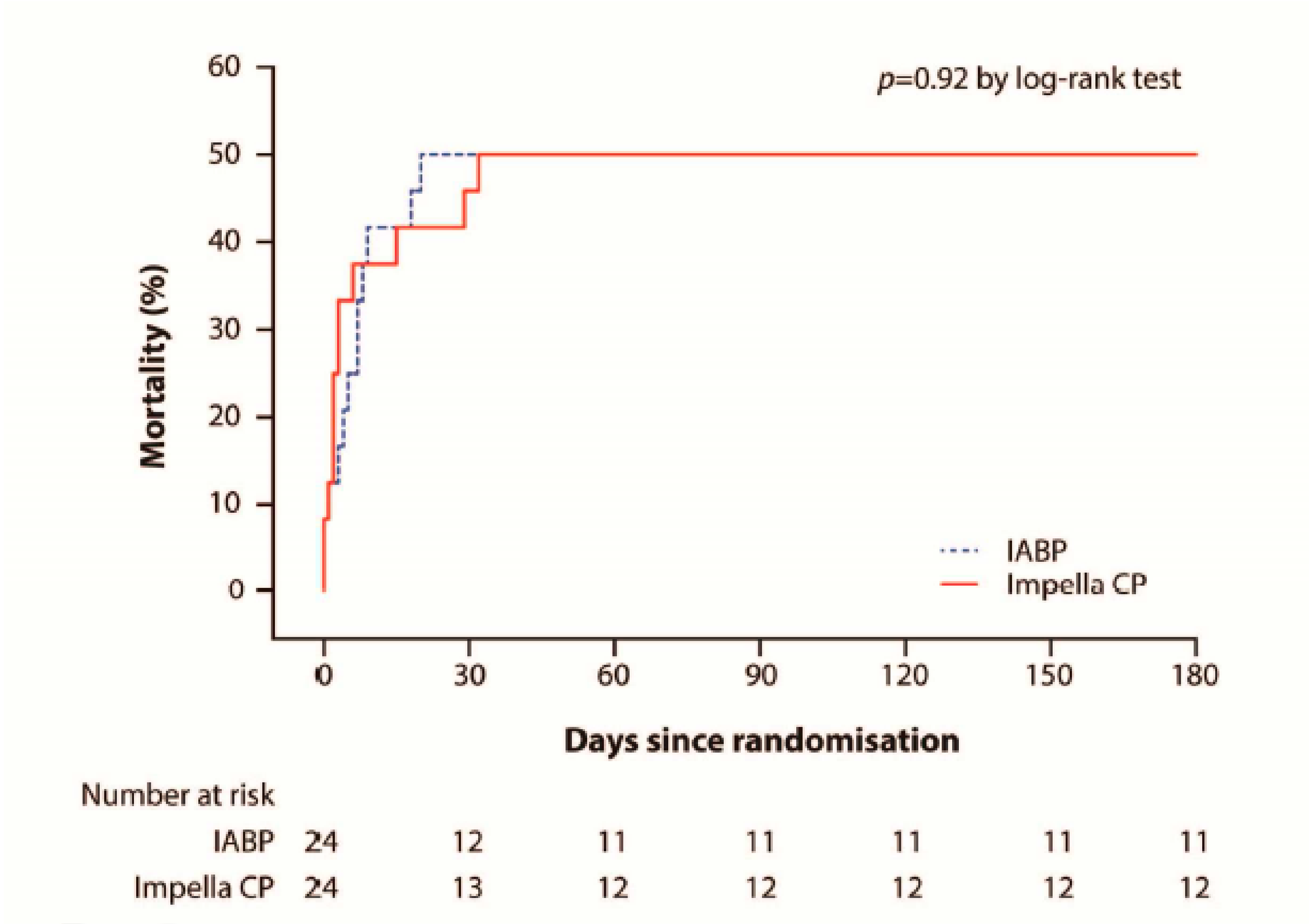
Cheng et al. European Heart Journal 2009l doi:10.1093

IMPRESS- IAB vs Impella CP for Shock

Table 1: Baseline characteristics

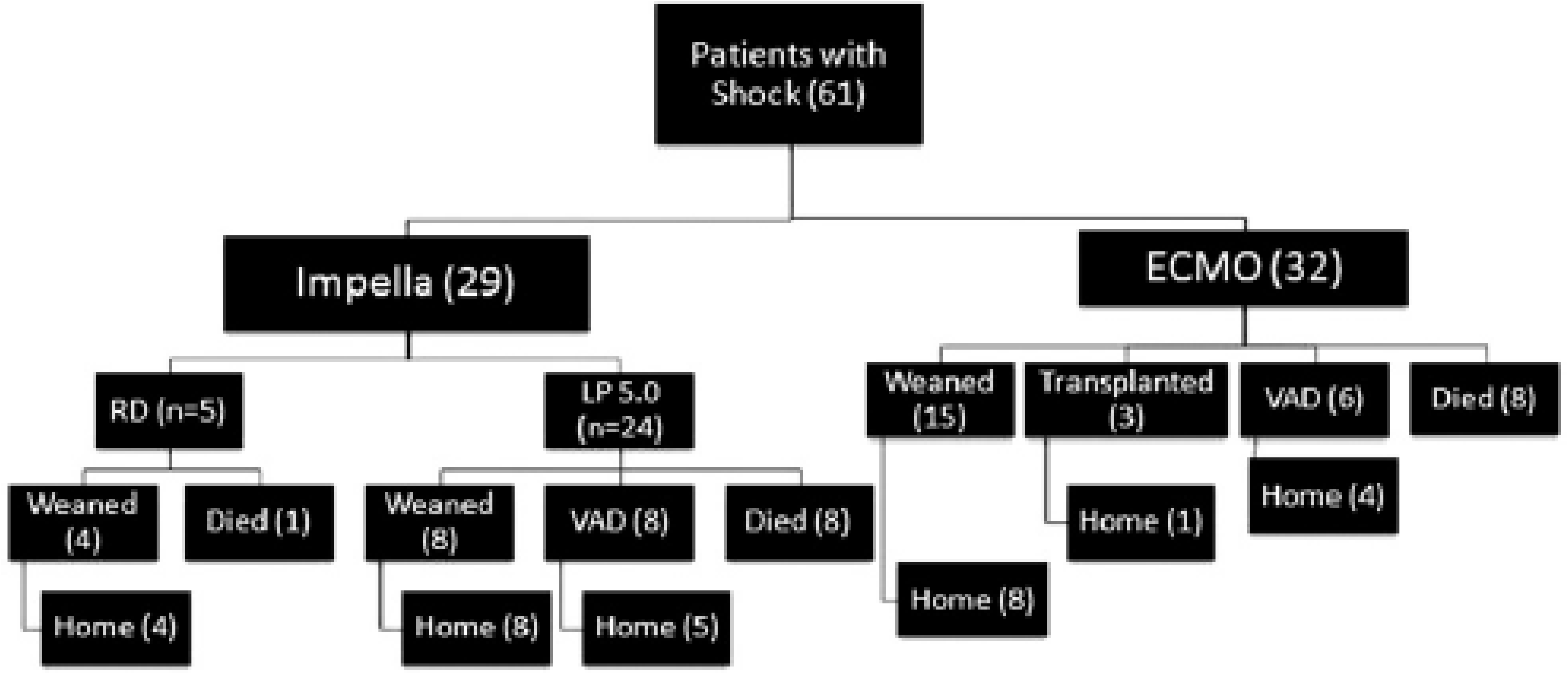
	Impella CP (n=24)	IABP (n=24)
Age (years)	58 ± 9	59 ± 11
Male sex, n/n (%)	18/24 (75)	20/24 (83)
Body mass index (kg/m2)	25 [23-26	26 [25-27]
Cardiovascular risk factors, n/n (%)		
Current smoking	11/18 (61)	6/19 (32)
Hypertension	4/20 (20)	6/21 (29)
Hypercholesterolemia	4/20 (20)	5/21 (24)
Diabetes mellitus	2/22 (9)	3/23 (13)
Prior myocardial infarction, n/n (%)	1/22 (5)	1/23 (4)
Prior stroke, n/n (%)	0/22 (0)	1/23 (4)
Known peripheral arterial disease, n/n (%)	2/23 (9)	0/23 (0)
Prior PCI or CABG, n/n (%)	1/22 (5)	0/23 (0)
Hemodynamic variables before randomization		
Heart rate (beats/min)	81 ± 21	83 ± 28
Mean arterial pressure (mm Hg)	66 ± 15	66 ± 15
Systolic blood pressure (mm Hg)	81 ± 17	84 ± 19
Diastolic blood pressure (mm Hg)	58 ± 22	57 ± 13
Medical therapy before randomization		
Catecholamines or inotropes, n/n (%)	24/24 (100)	22/24 (92)
Mechanical ventilation, n/n (%)	24/24 (100)	24/24 (100)
Cardiac arrest before randomization, n/n (%)	24/24 (100)	20/24 (83)
Witnessed arrest, n/n (%)	22/24 (92)	17/20 (85)
First rhythm VT/VF, n/n (%)	22/24 (92)	17/20 (85)
Time till return of spontaneous circulation (min)	21 [15-46]	27 [15-52]
Traumatic injuries at admission, n/n (%)	5/24 (21)	2/24 (8)
Blood values on admission $		
Lactate (mmol/L)	7.5 ± 3.2	8.9 ± 6.6
Hemoglobin (mmol/L)	8.6 ± 1.2	8.6 ± 1.2
Creatinine (mg/dL)	96 ± 29	102 ± 22
Glucose (mmol/L)	16.2 ± 4.7	14.1 ± 5.3
Arterial pH	7.14 ± 0.14	7.17 ± 0.17
Baseline echocardiography *		
Estimated left ventricular ejection fraction, n/n (%)		
< 20%	5/22 (23)	8/18 (44)
20-40%	10/22 (46)	6/18 (33)
> 40%	7/22 (32)	4/18 (22)

- Multicenter, open label, randomized, N= 48
- IABP vs Impella CP, 1:1 randomization
- STEMI with immediate PCI
- CS as defined by SBP < 90 for 30 minutes or requirement
- for inotropes / pressors to maintain SBP > 90
- ALL Pts were VENTILATOR dependent to be enrolled!



Zeymer and Thiele. JACC Jan 2017. p 288-290

IMPELLA 5.0 vs ECMO



38% Mortality 30 days with Impella 5.0

44% Mortality 30 days with ECMO

TABLE 2. Outcomes: ventricular assist device, extracorporeal life support, interquartile range, and standard deviation

	ECLS (n = 32)	Impella (n = 29)	*P*
Duration of support (hr) (median ± IQR)	46.3 (27–88)	63.3 (41–142)	.16
Average flow (L/min) (mean ± SD)	4.0 ± 0.1	3.7 ± 0.1	.06
Arterial thromboembolism (n) (%)	6 (18.8)	1 (3.4)	.04
Weaned (n) (%)	15 (46.9)	12 (41.4)	.67
Bridge to VAD (n) (%)	6 (18.8)	8 (27.6)	.41
Bridge to transplant (n) (%)	3 (9.4)	0	.09
30-day mortality (n) (%)	14 (43.8)	11 (37.9)	.64
Discharged home (n) (%)	13 (40.6)	17 (58.6)	.16

TABLE 3. Blood product use: Extracorporeal life support, packed red blood cells, and fresh frozen plasma

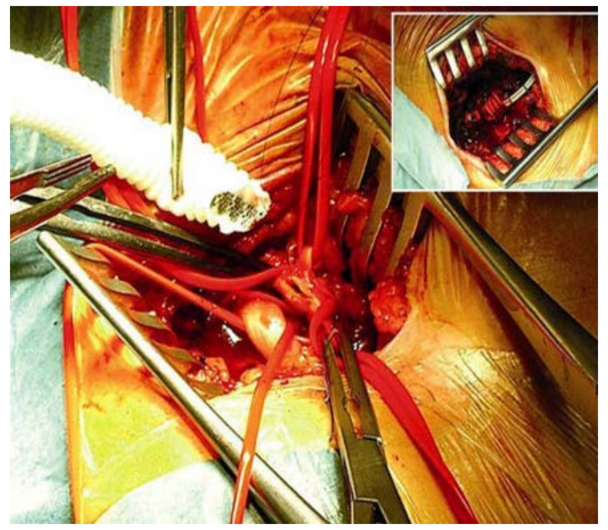
	ECLS (n = 32)	Impella (n = 29)	*P*
PRBC (median [IQR])	18.0 (9–34)	4 (2–9)	< .001
FFP (median [IQR])	14 (8–28)	2 (0–8)	< .001
Platelets (median [IQR])	5 (0.5–8.5)	0 (0–2)	< .001
Factor VIIa (%)	21.8	13.8	.51

Conclusions: Both extracorporeal life support and axial flow pumps provided adequate support in patients with various etiologies of cardiogenic shock. Axial-flow pump may be an optimal type of support for patients with univentricular failure, whereas extracorporeal life support could be reserved for patients with biventricular failure or combined respiratory and circulatory failure. (J Thorac Cardiovasc Surg 2011;142:60-5)

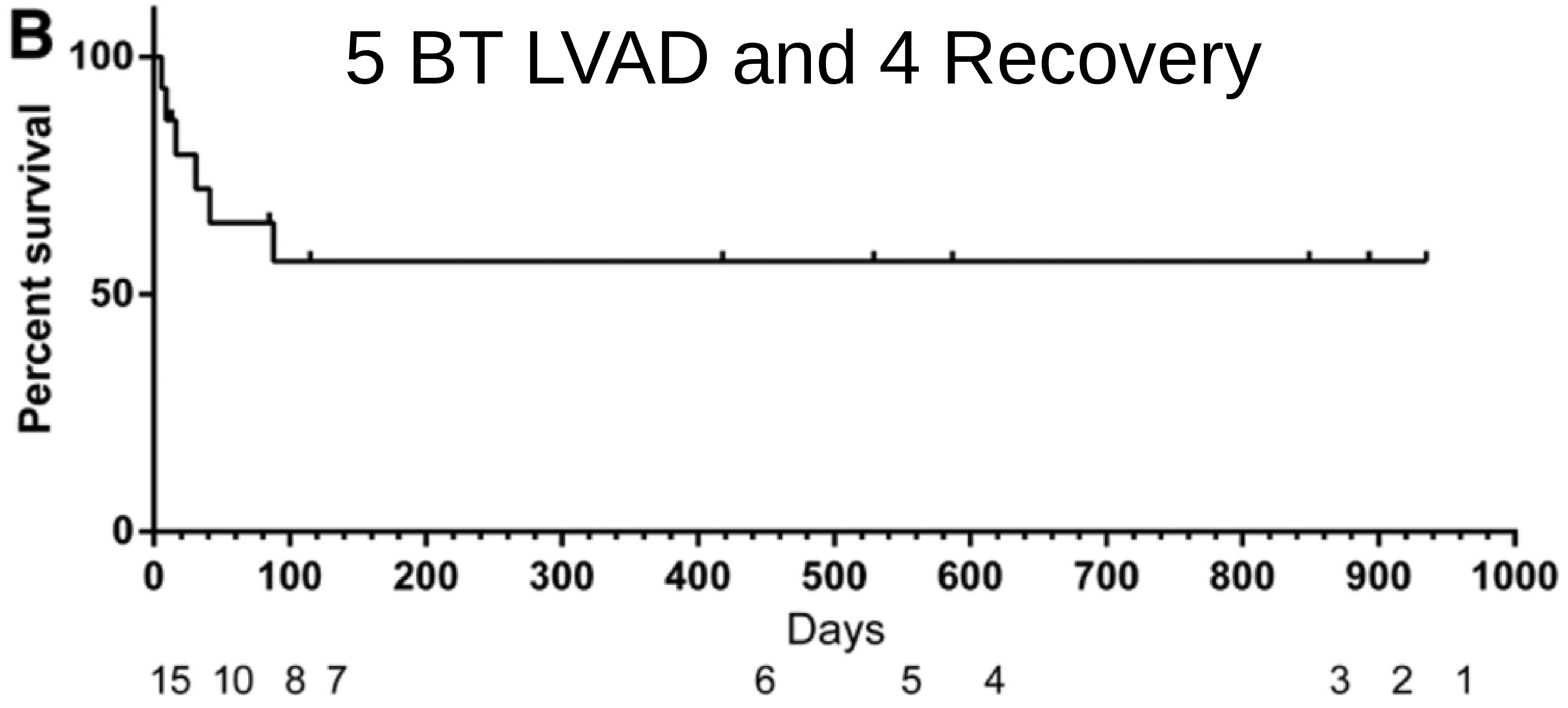
Lamarche, JTCVS 2011,142:60-5

Temporary Left Ventricular Assist Device Through an Axillary Access is a Promising Approach to Improve Outcomes in Refractory Cardiogenic Shock

Parameter	Outcome
Gender	14/15 (93%) male
Age	Mean: 53 ± 15, range: 20–70
Condition causing CS	Acute MI (n = 6), acute decompensated dilated cardiomyopathy (n = 7), postcardiotomy (n = 2)
INTERMACS score before Impella	1 (n = 14), 2 (n = 1)



Parameter	Time in Days; Median(Range)
Pre-Impella inotrope dependence (n = 15)	2 (0–10)
Pre-Impella IABP (n = 10)	2 (<1–7)
Time with Impella	9 (5–30)
Post-Impella inotrope dependence	15 (0–23)
Post-Impella days to extubation	1.63 (0.24–14.28)
Post-Impella ICU stay length	18 (7–34)



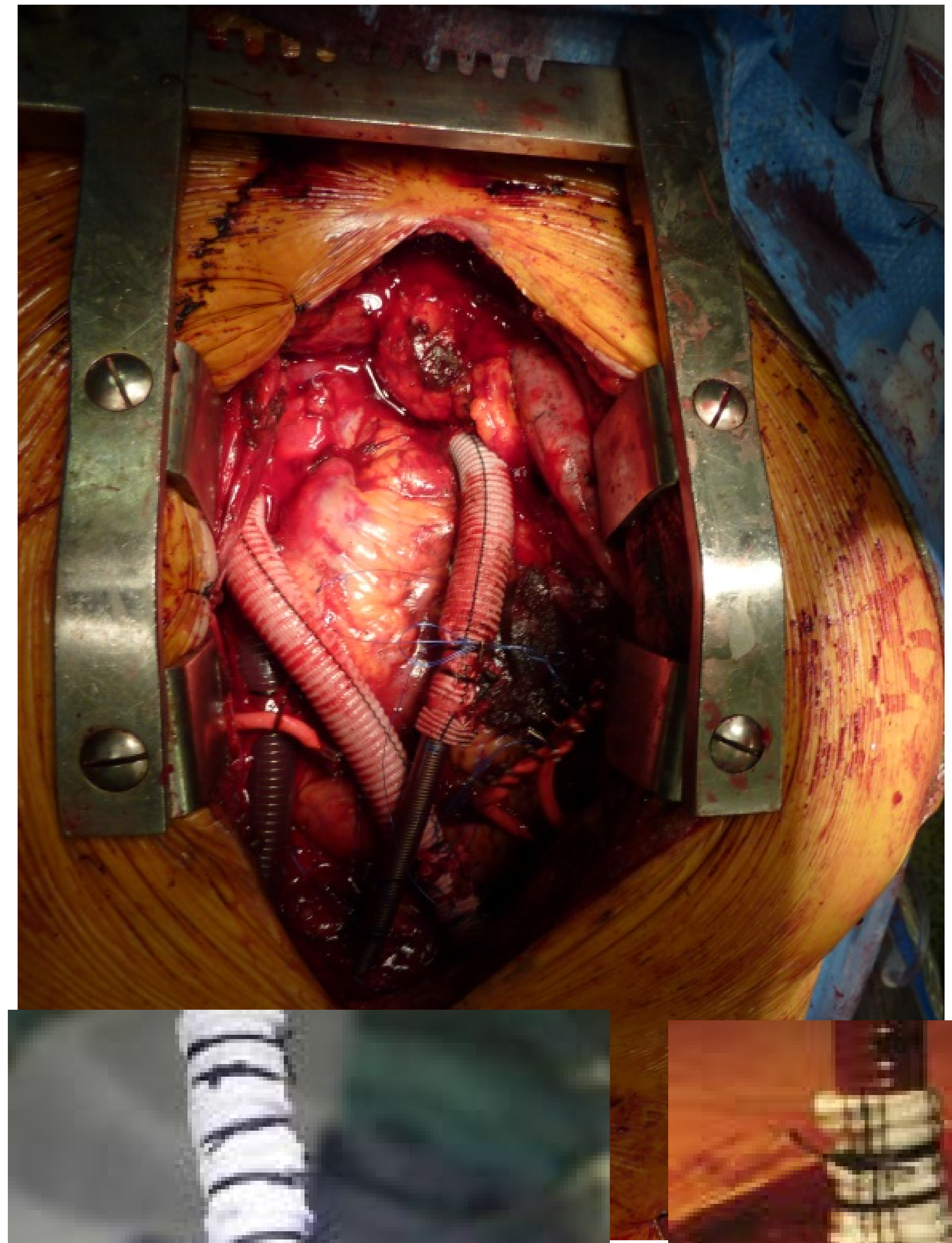
Major Causes of Death (n = 6)

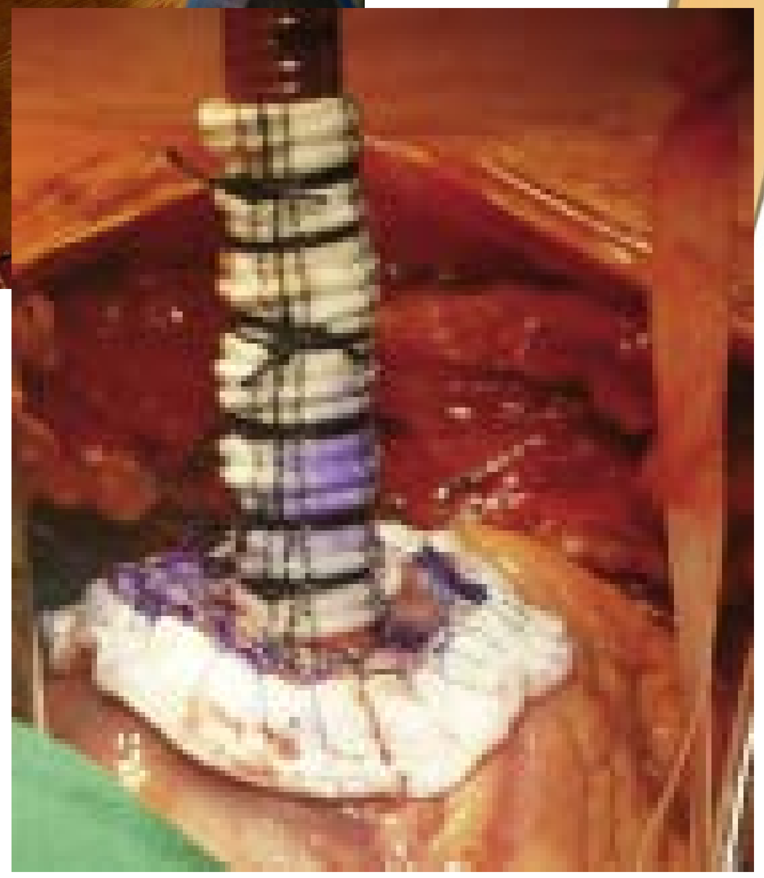
Cause of Death	Number
Ventricular fibrillation	1
Multiorgan failure	1
Sudden death	1
Gastrointestinal bleeding	1
Support withdrawn	2

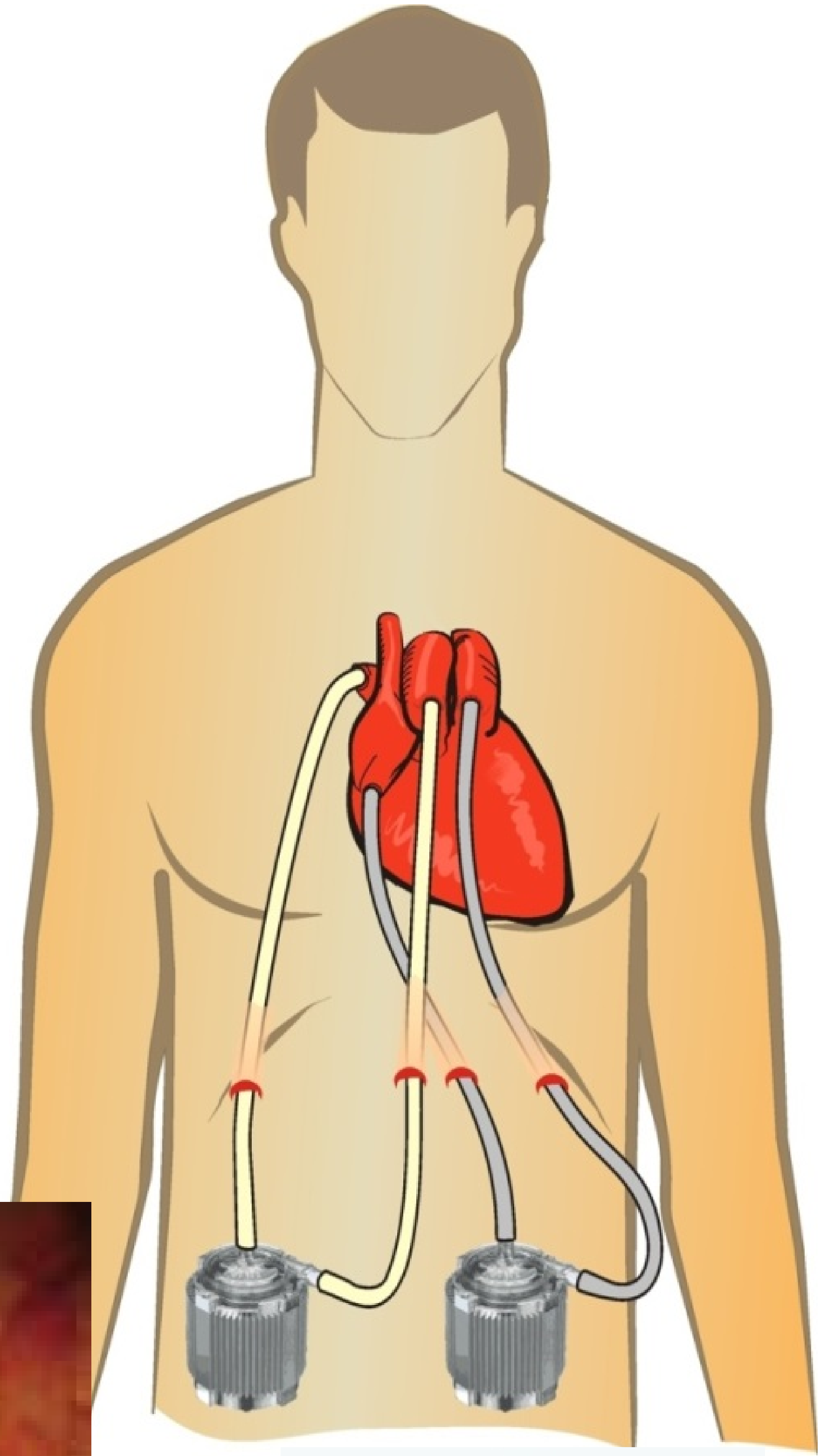
67% pts. were mobilized
73% extubated

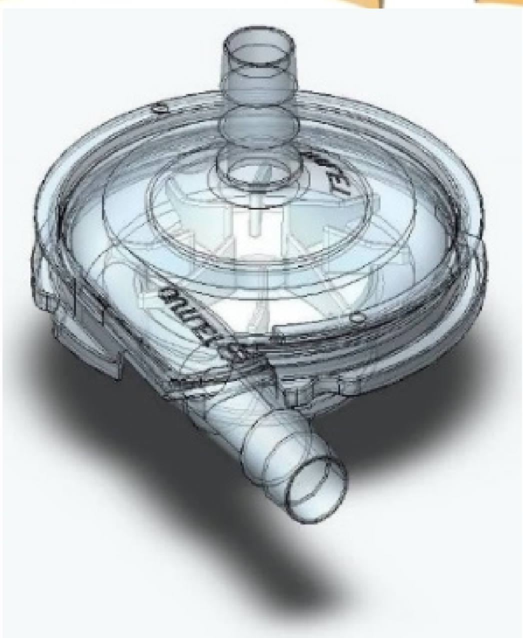
ASAIO J. 2015 ; 61(3): 253–258.

When longer support is needed: CentriMag® in Cardiogenic Shock





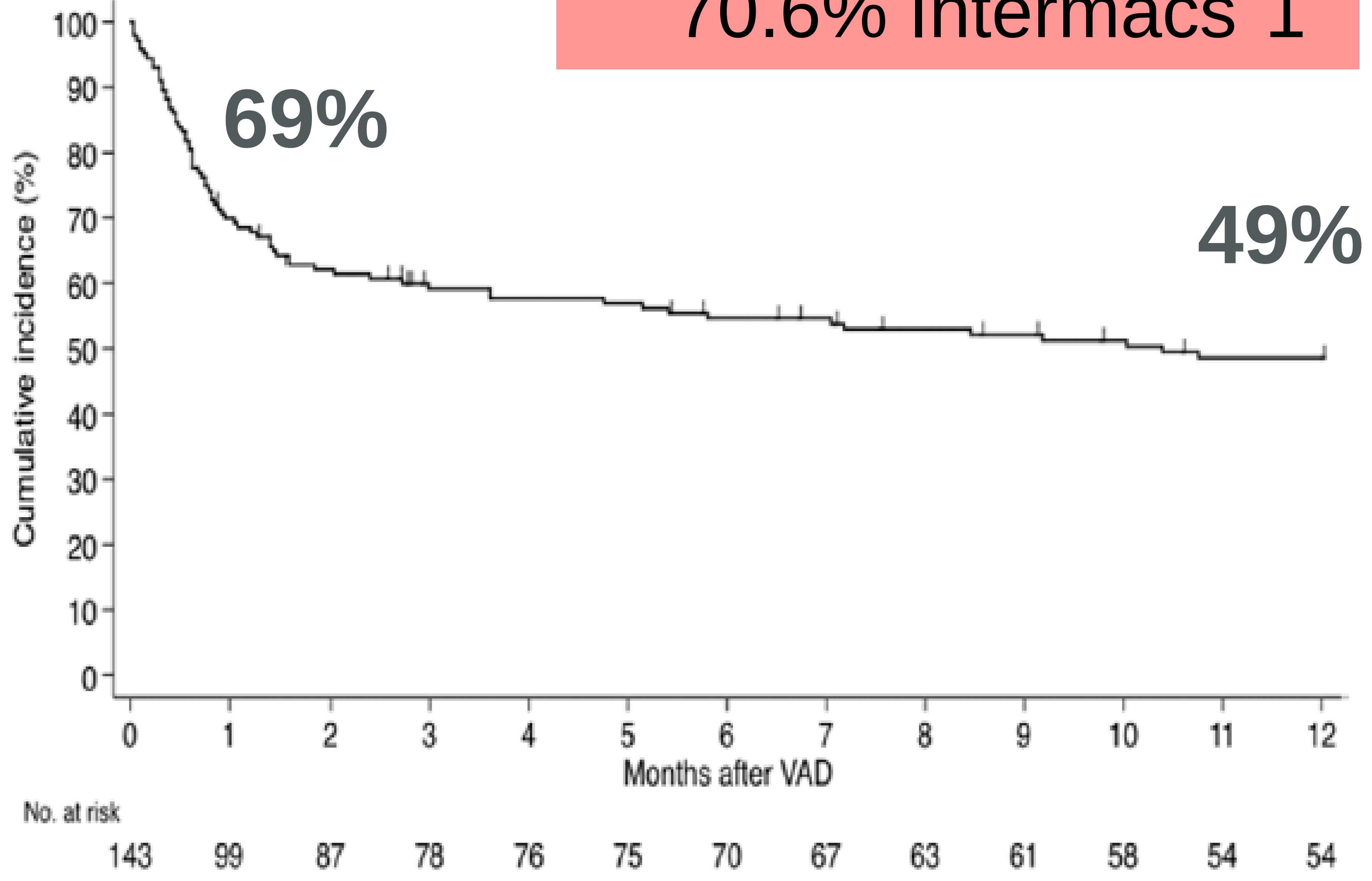




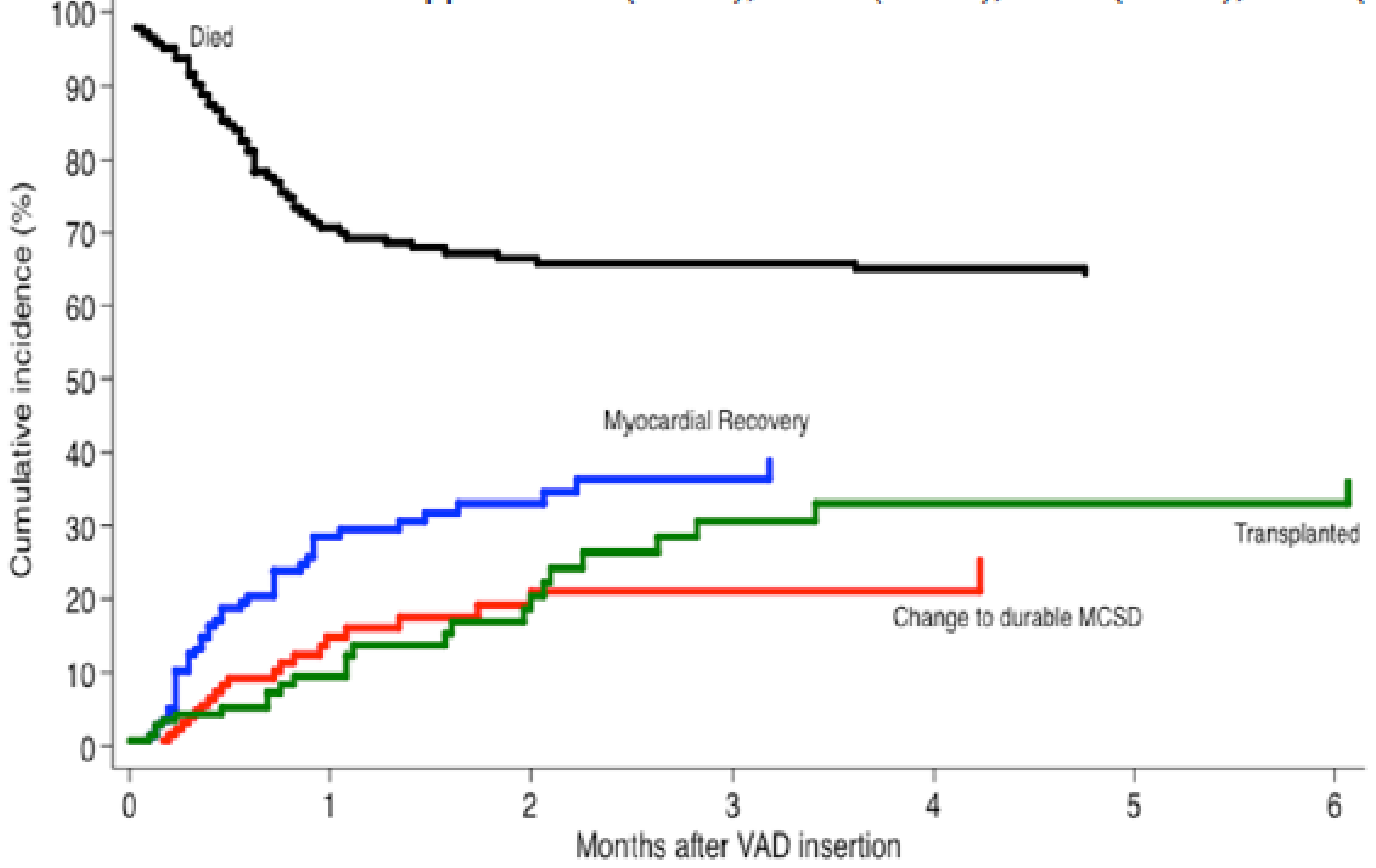
Bridge-to-Decision Therapy With a Continuous-Flow External Ventricular Assist Device in Refractory Cardiogenic Shock of Various Causes

143 pts (148 Cmag)

70.6% Intermacs 1



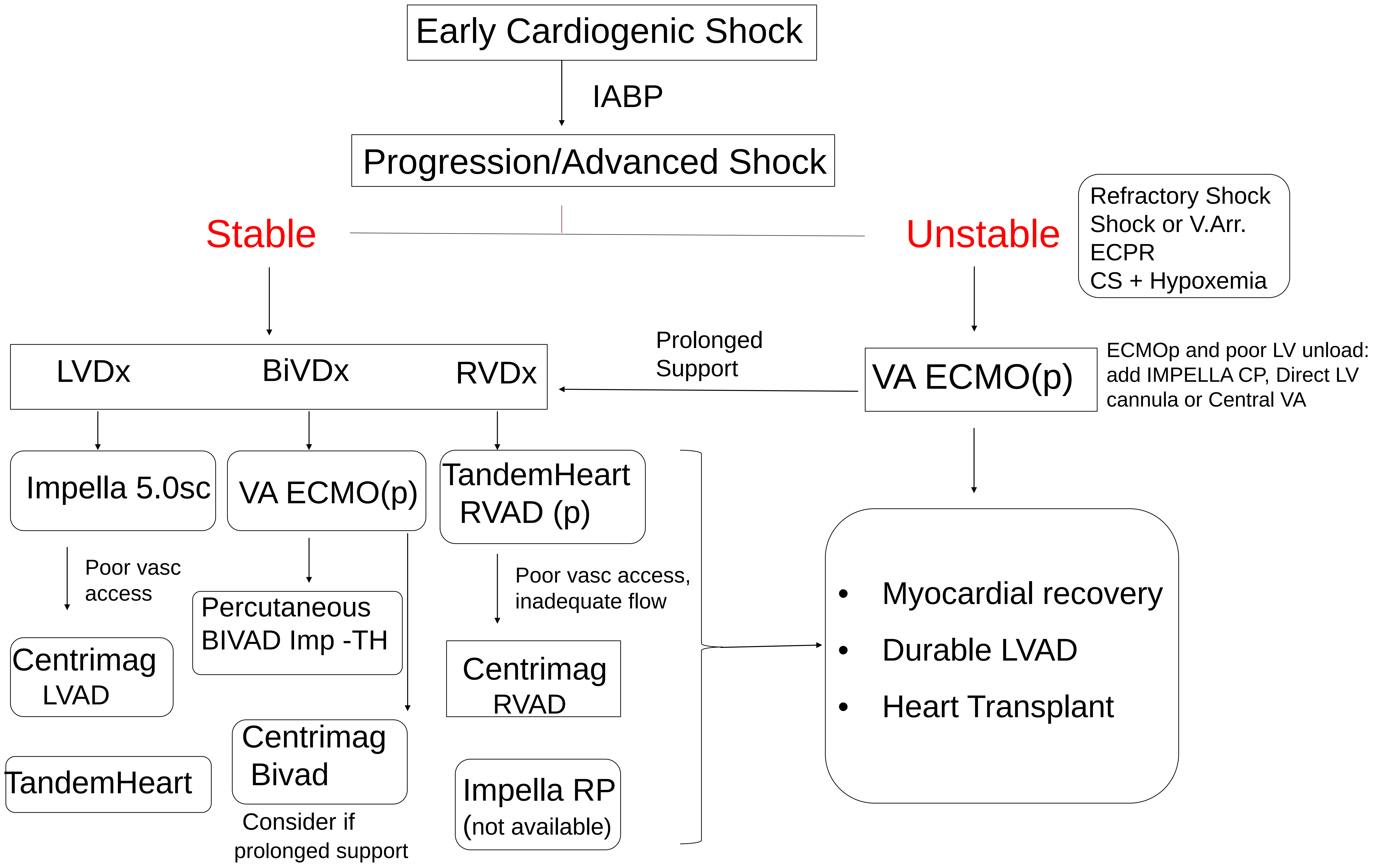
n	All device runs (158)	BiVAD (105)	LVAD (12)	RVAD (41)
Duration of support	20.5 (±20.6),	21.1 (±20.8),	18.8 (±17.1),	19.5 (±21.4),



	Overall	FMM	PCS	GF	RVF-p-iLVAD	*P* Value
n	143	71 (AMI 45.1%,	37 (CABG 35.1%,	22 (early 72.7%,	13	
INTERMACS 1, %	70.6	63.3	83.8	77.3	61.5	0.12
Intubated, %	62.9	70.4	62.2	50.0	46.2	0.18
CVVH, %	22.4	11.3	37.8	27.3	30.8	0.012
IABP, %	54.6	59.2	51.4	59.1	30.8	0.27
ECMO, %	19.6	22.5	21.6	13.6	7.7	0.54

Circ Heart Fail. 2014;7:799-806

PENN Cardiogenic Shock: Device Selection



Summary

- TMCS are increasingly used as a bridge to decision in patients with CS .

- The technical simplicity and lack of definite guidelines has favored the use of percutaneous technologies, without evidence supporting their superiority over IABP with the exception of ECMO.

- Limitations of flow and/or LV unloading of percutaneous TCS leads frequently to the need to combine devices with the potential to increase vascular complications and hemolysis.

- Surgically implanted devices are still a useful strategy as they can provide stable support with adequate flow and LV unloading.

- The indications and selection of support is critical and their use should be directed by an experienced team (Shock Team) capable of defining the correct candidate and destination alternatives, but also with the experience to identify futile support .

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Thank You

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