Predicting Outcomes in VA ECMO Patients

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VA-ECMO

- Cardiogenic shock
  - AMI
  - Cardiomyopathic process
    - Fulminant myocarditis
    - Sepsis-associated cardiomyopathy
  - Bridge to recovery in FM
  - Post cardiotomy shock
    - Weaning failure from CPB
- Pulmonary HTN or embolism c RHF
- CPR using VA-ECMO
  - Extracorporeal CPR (ECPR)

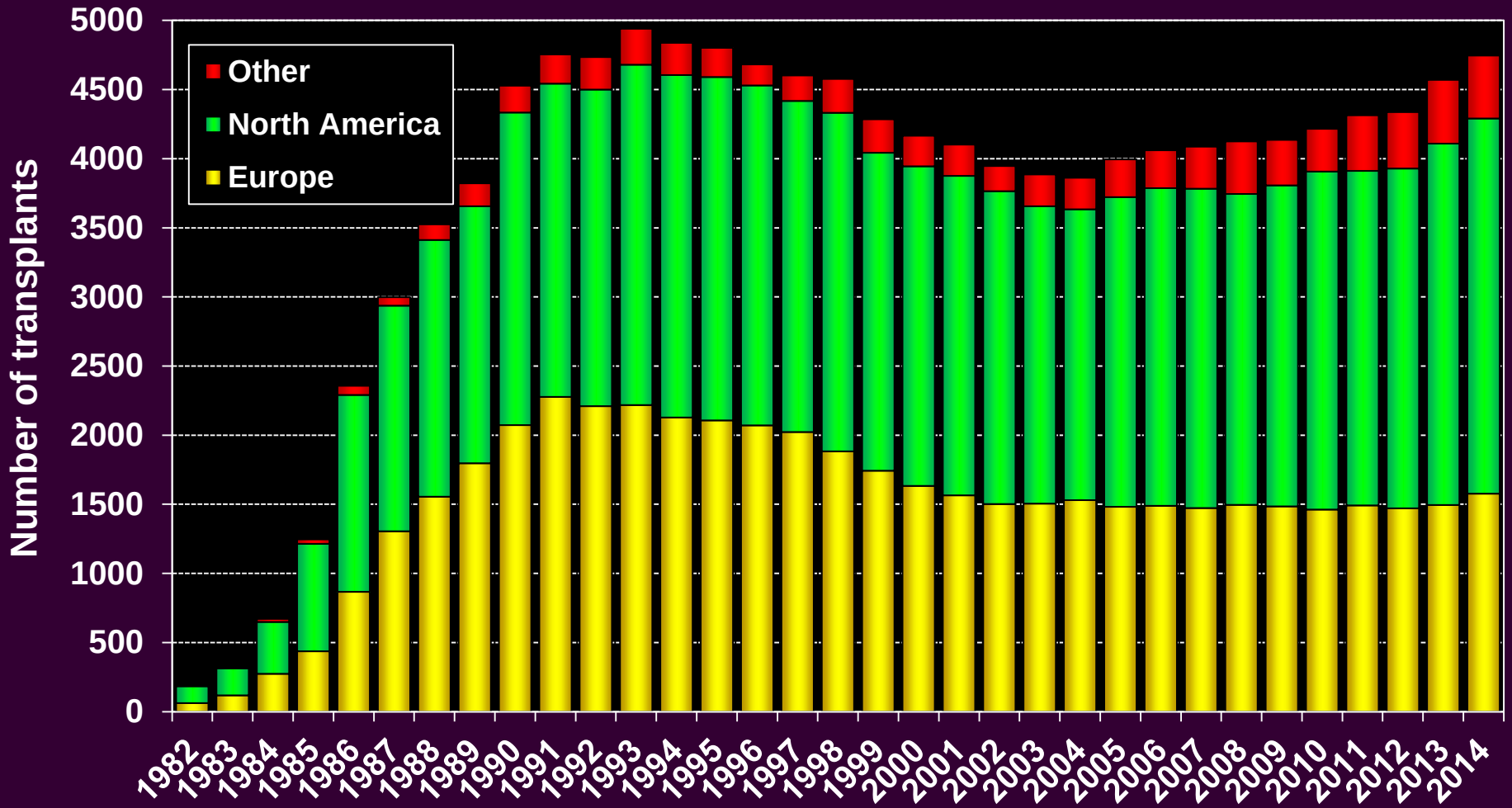
VA-ECMO

- **Class IV/Stage D HF**
  - **Bridge to LVAD or HTx**
  - **Bridge to decision in rapid decompensating HF**

Heart transplantation (HTx)

- Most effective and efficient treatment for ESHF with low cardiac output
- But, ….

Adult and Pediatric Heart Transplants
Number of Transplants by Year and Location



NOTE: This figure includes only the heart transplants that are reported to the ISHLT Transplant Registry. As such, the presented data may not mirror the changes in the number of heart transplants performed worldwide.

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2016
JHLT. 2016 Oct; 35(10): 1149-1205

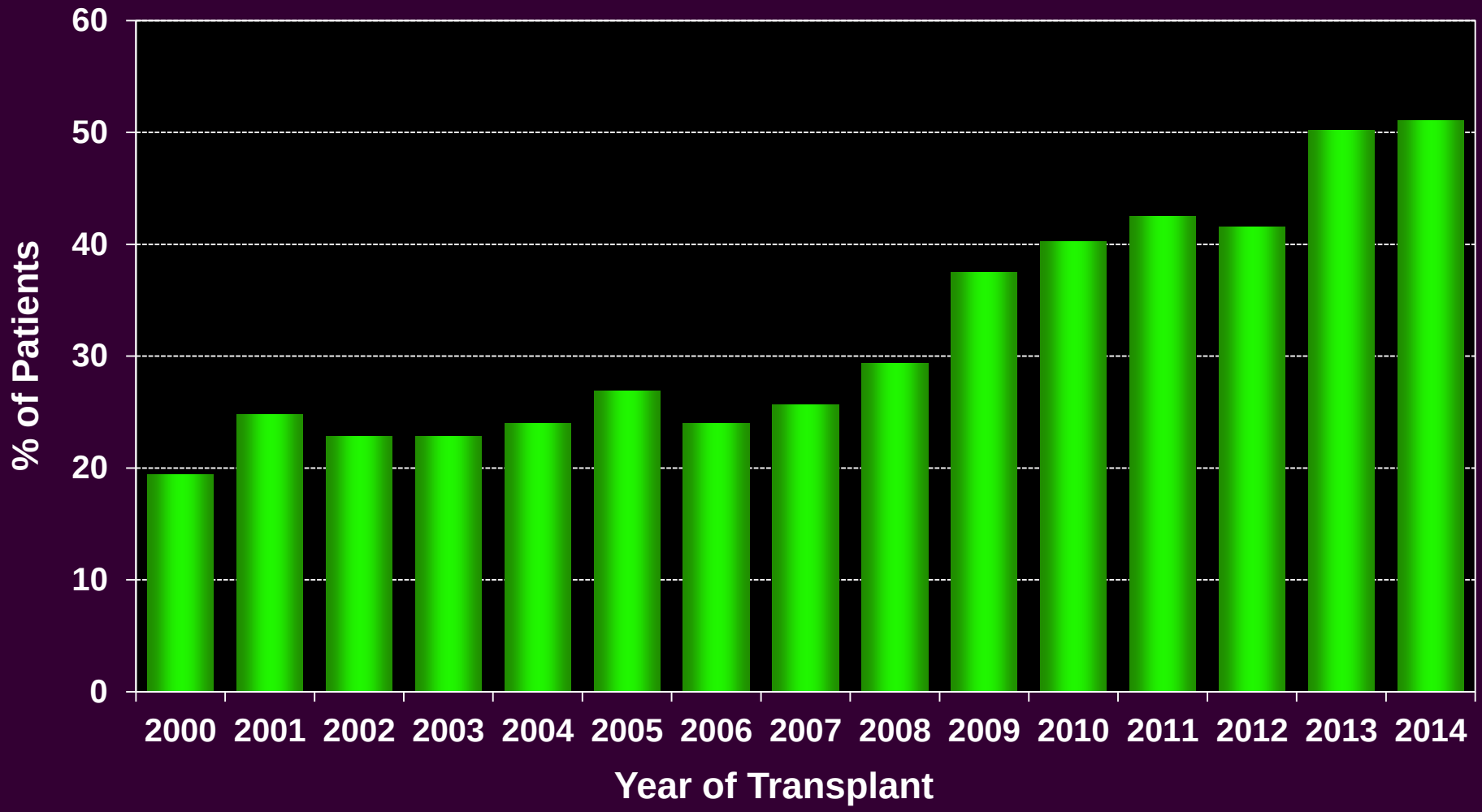
Limitation of HTx

- Donor shortages always matters
- Mortality rate rises on the HTx waiting list

Adult Heart Transplants

% of Patients Bridged with Mechanical Circulatory Support*

(Transplants: January 2000 – December 2014)



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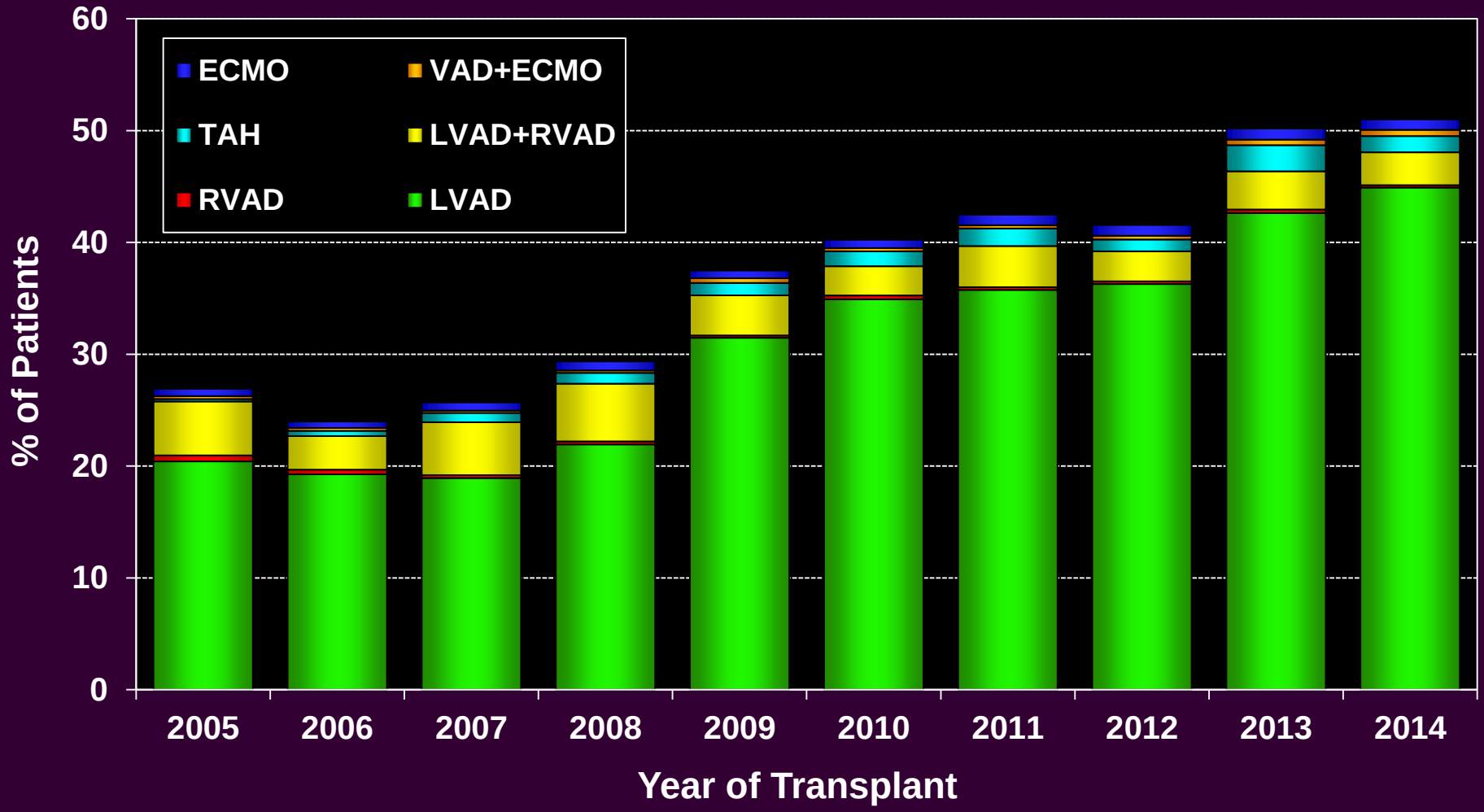
* LVAD, RVAD, TAH, ECMO

Adult Heart Transplants

% of Patients Bridged with Mechanical Circulatory Support* by Year and Device Type



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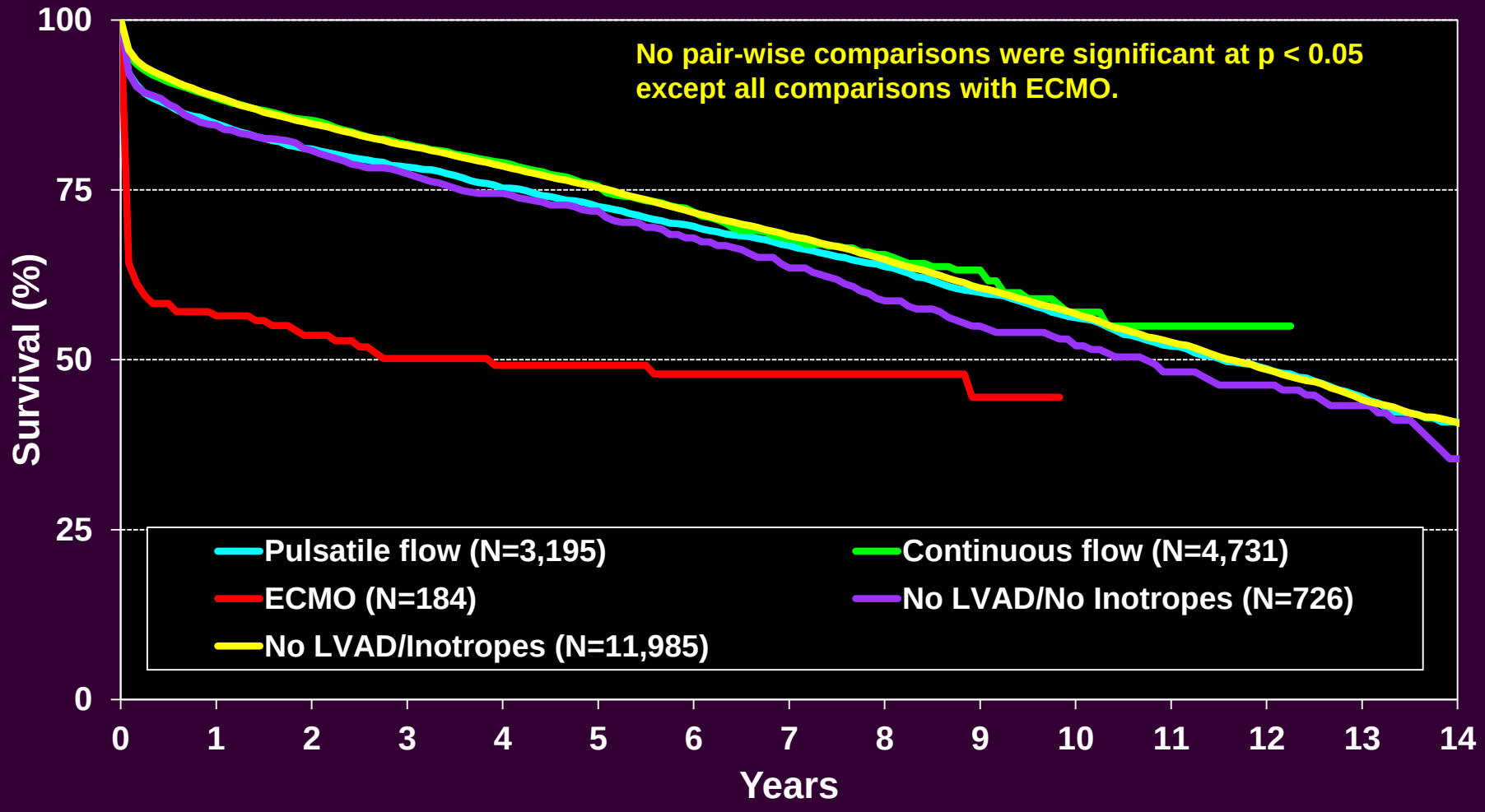
* LVAD, RVAD, TAH, ECMO

Adult Heart Transplants

Kaplan-Meier Survival by Pre-Transplant Mechanical Circulatory Support Use (Transplants: January 1999 – June 2014)



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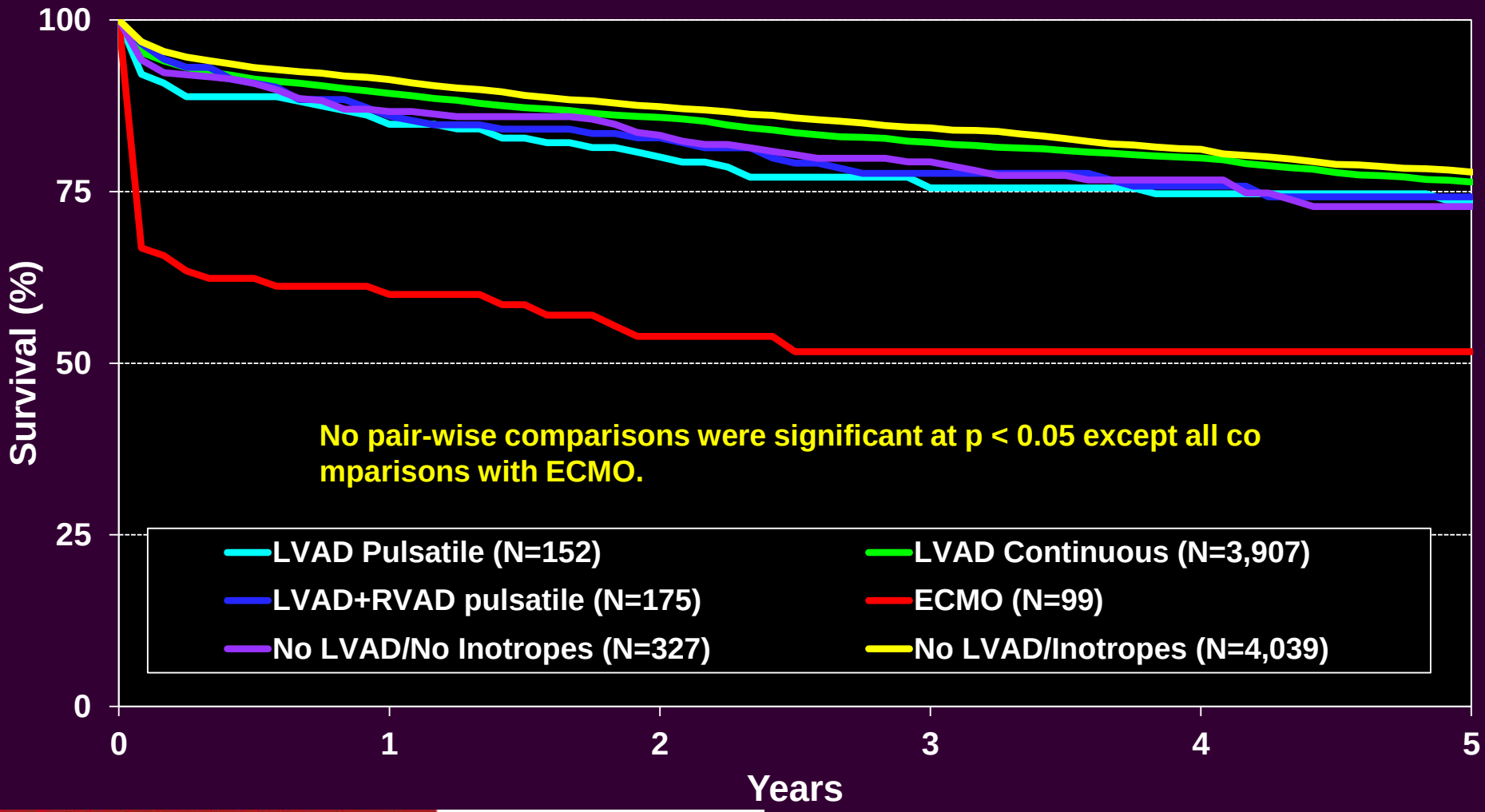
Adult Heart Transplants

Kaplan-Meier Survival by Pre-Transplant Mechanical Circulatory Support Use (Transplants: January 2009 – June 2014)



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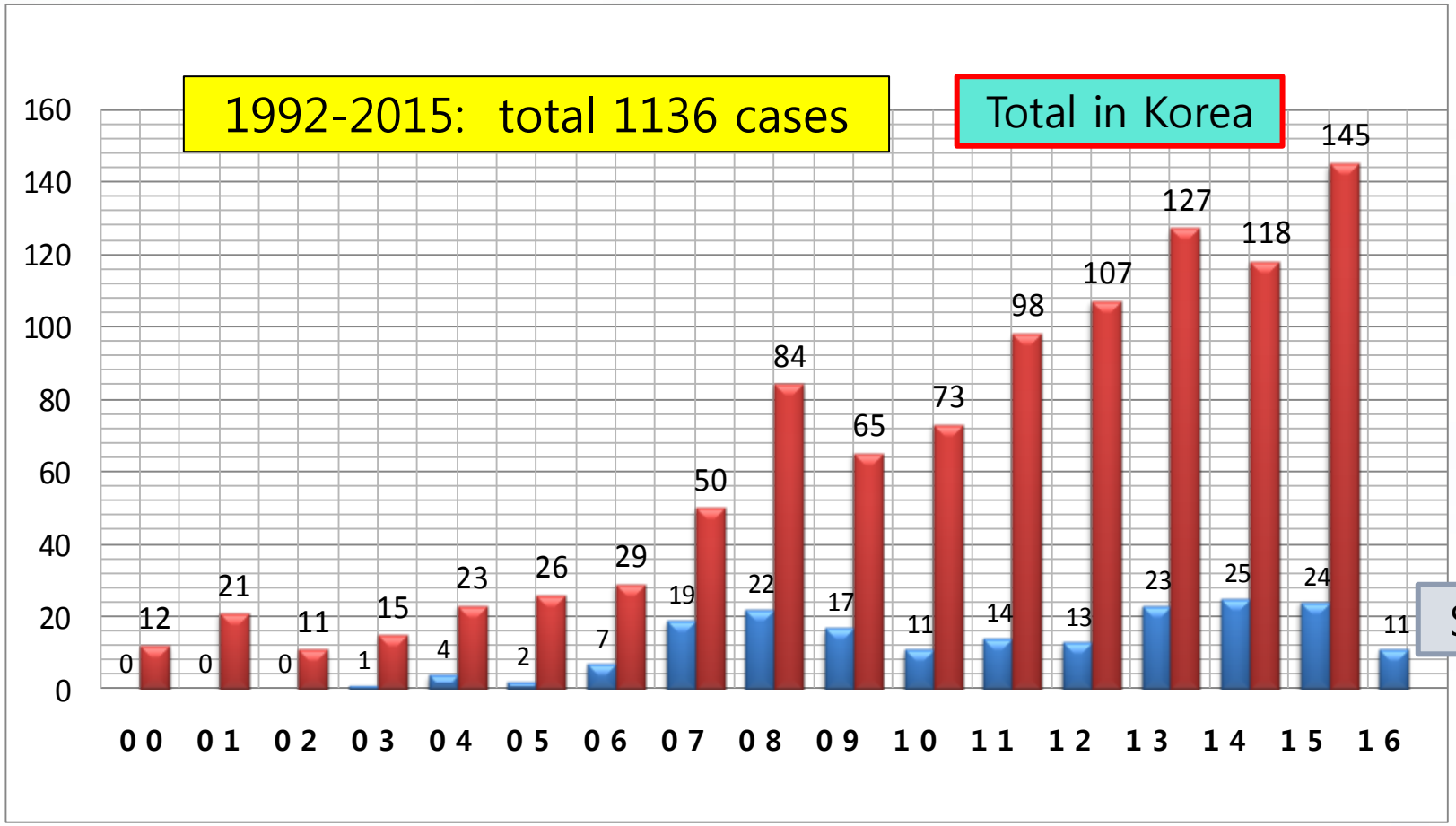
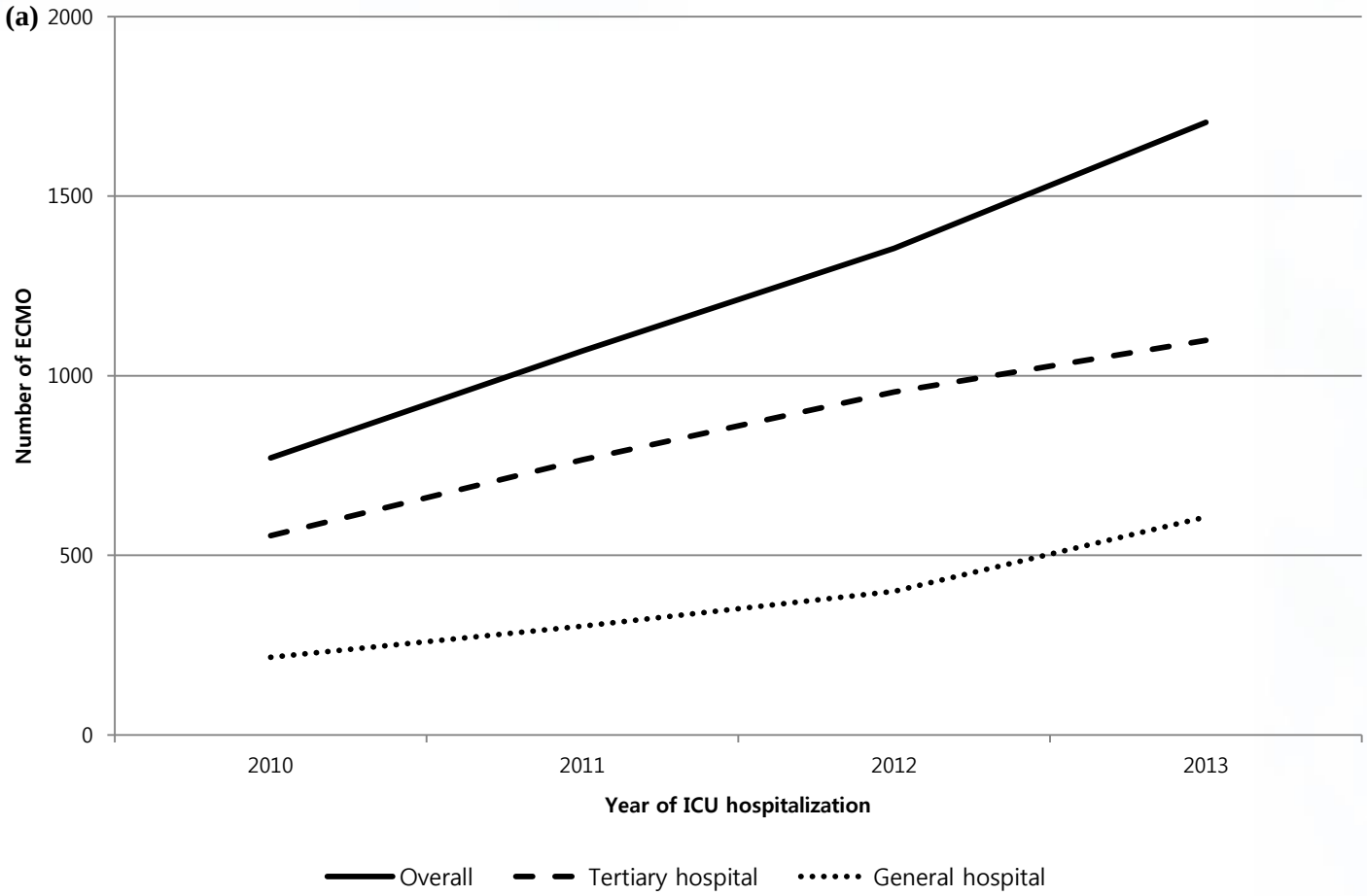
Heart transplant in Korea



http://www.konos.go.kr

Use of ECMO in Korea



Melvin and Cho YH et al. From HIRA, Unpublished data

Definition of Recipients Status

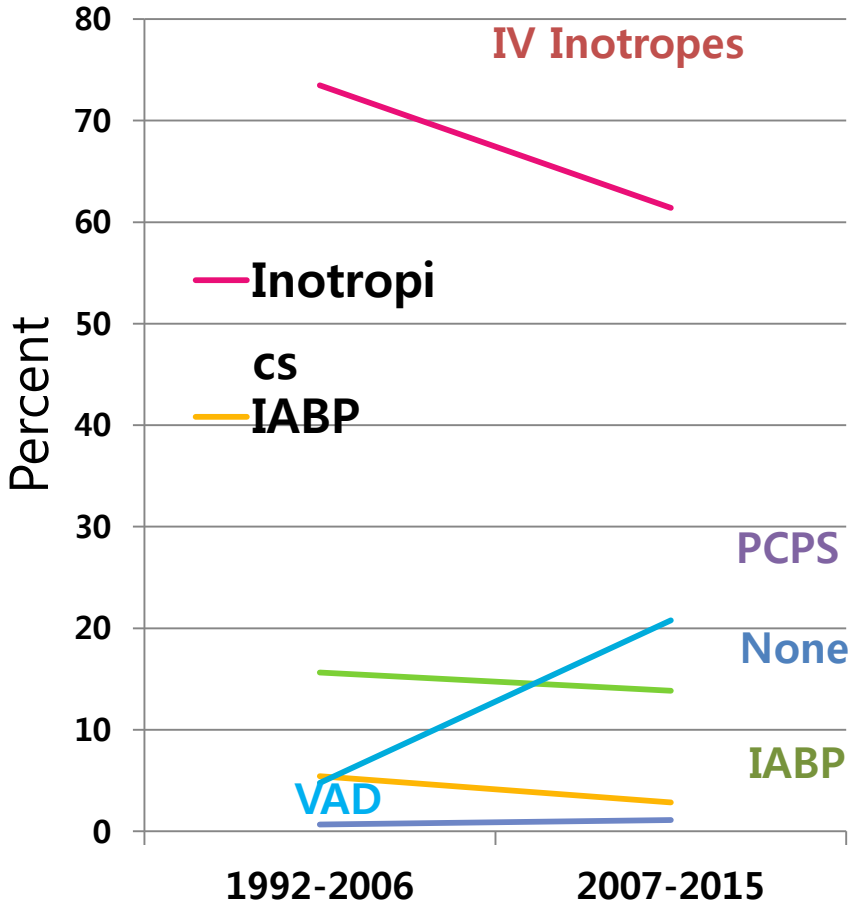
STATUS 0

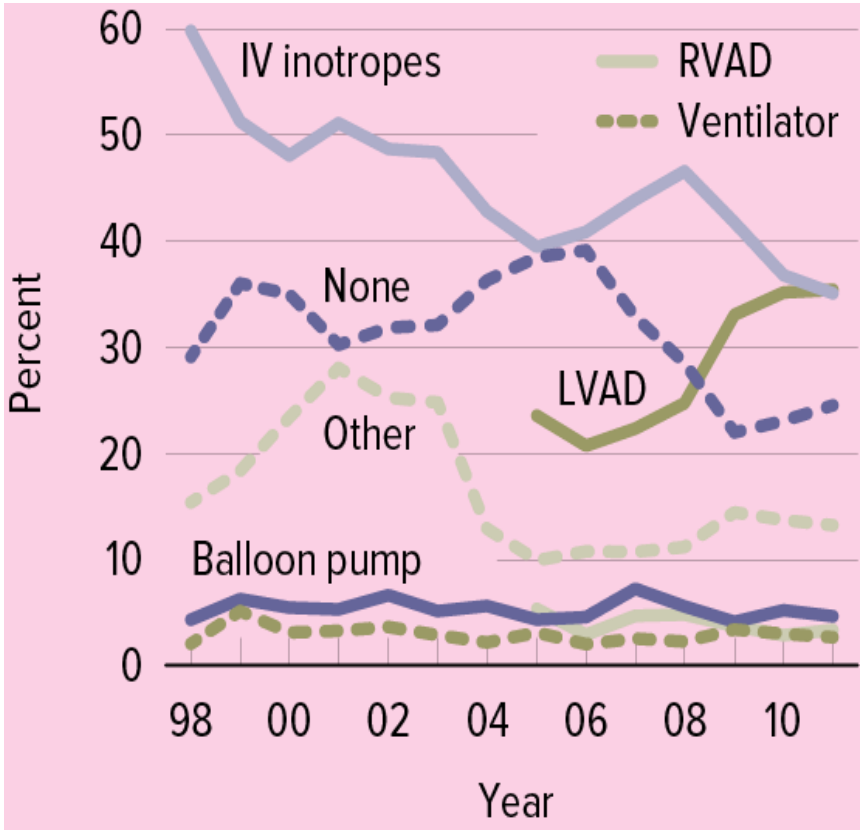
- LVAD or RVAD with ventilator
- PCPS with ventilator

STATUS 1

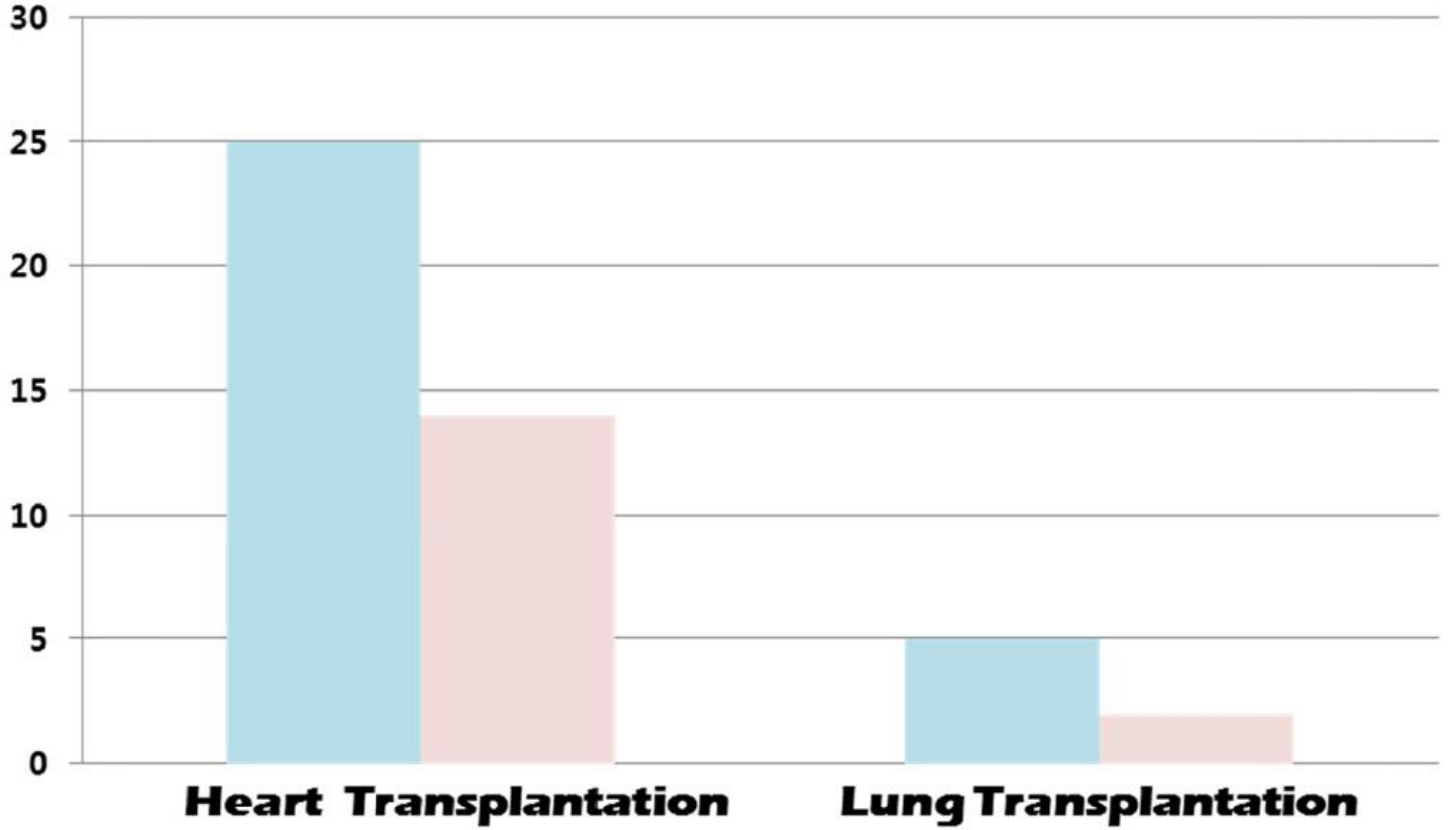
- Total artificial heart
- LVAD or RVAD without ventilator
- PCPS without ventilator
- Intra-aortic pump (IABP)
- Unstable critical condition with severe HF on ventilator
- Intravenous inotropic injection for more than 4 consecutive weeks

Circulatory support prior to HTx





Bridge to Transplantation (2014)



심장 이식 25건 중
ECMO유지 중 이식환자 14명
(56%)

폐 이식 5건 중
ECMO유지 중 이식환자 2명
(40%)

HTx under ECLS supprot

- Refractory cardiogenic shock c ECLS at SMC
- On KONOS waiting list for HTx
- N=49 (2004.~2013.8)
  - 20 patients died while waiting for transplantation.
  - Reasons of ECLS withdrawal were irreversible MOF and sepsis in 18 (90%) and family request in 2 (10%).
  - In 4 patients, ECLS weaned-off and HTx later.
- 25 underwent HTx under ECLS.
- 7 (28%) died within 1 year after HTx.

Cho et al. ASAIO Journal 2015; 61:139–143

ECMO as a Bridge to HTx:
Importance of Organ Failure in Recipient Selection

Table 1. Baseline Characteristics of All Patients (n = 25)

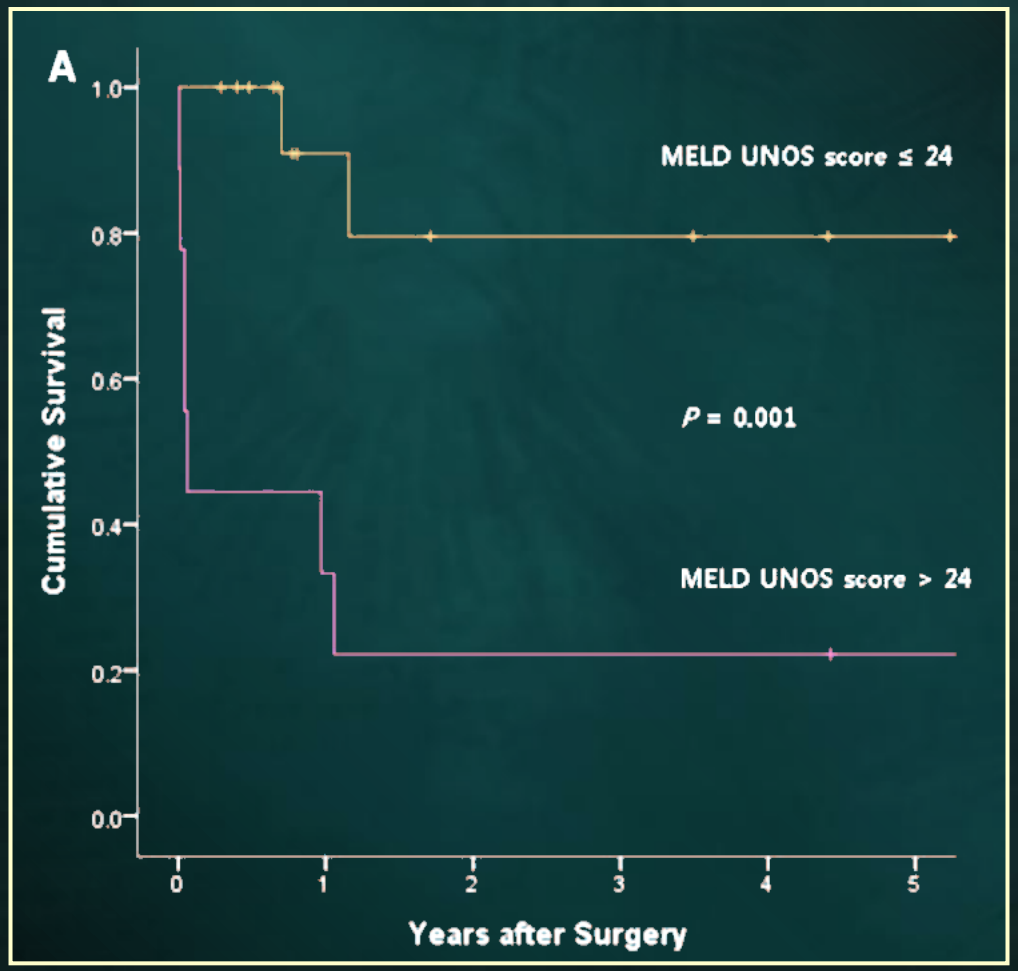
Variables	Values
Women	7 (28%)
Mean age (years)	41.3 (17.2)
Cardiac arrest before ECLS	10 (40%)
Duration of ECLS before transplantation (days)	8 (7.8)
LV ejection fraction (%)	29.7 (14.3)
Previous cardiac operation	8 (32%)
Units of transfusion	52.2(50.4)
C-reactive protein (mg/dl)	9.7 (7.3)
White cell count ($\times 10^3/\mu l$)	13.51 (7.668)
Total bilirubin (mg/dl)	8.4 (11.5)
INR	1.5 (0.5)
Platelet ($\times 10^3/\mu l$)	108.8 (43.3)
Creatinine (mg/dl)	1.5 (0.9)
PaO_2 / FiO_2 (mm Hg)	369.6 (161.7)
SOFA score	13.1 (3.5)
SOFA score > 13 (%)	12 (48)
MELD UNOS score	21.9 (7.3)
MELD UNOS score > 24	9 (36%)
Causes of heart failure	
Ischemia	5 (20%)
Myocarditis	2 (8%)
Congenital anomaly	1 (4%)
Cardiac allograft rejection	4 (16%)
Idiopathic DCMP	8 (32%)
Other	5 (20%)
Dialysis	7 (28%)
Cold ischemic time (minutes)	118.3 (60.7)
CPB time (minutes)	171.8 (30.3)

$$MELD = 3.78\times\ln[sBil(mg/dL)] + 11.2\times\ln[INR] + 9.57\times\ln[sCr\ (mg/dL)] + 6.43\times etiology$$

(0: cholestatic or alcoholic, 1-otherwise)

Cho et al. ASAIO Journal 2015; 61:139–143

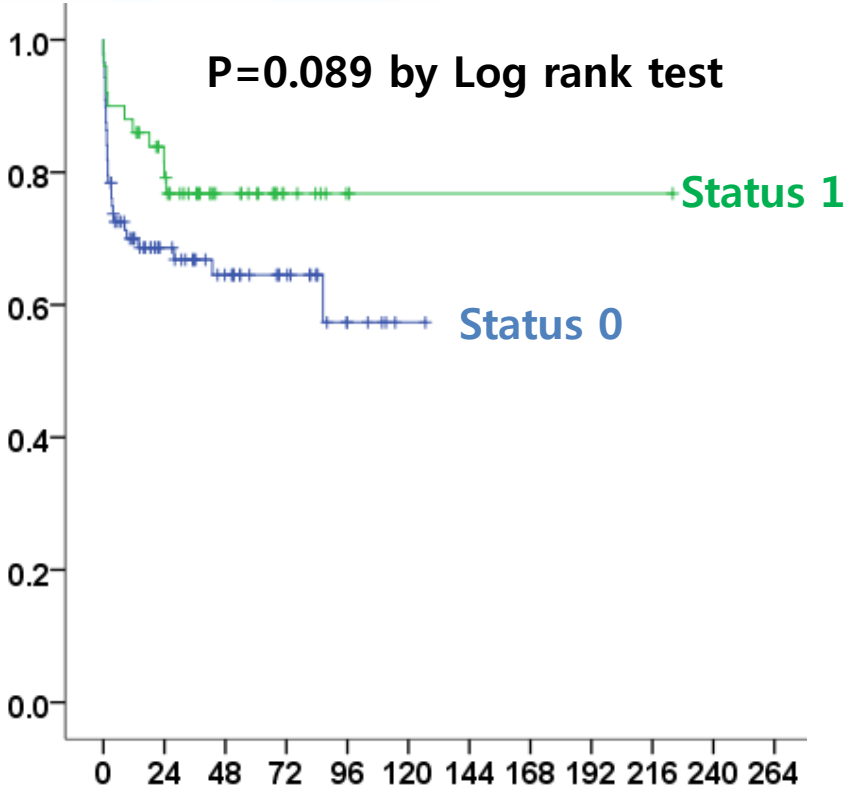
ECMO as a Bridge to HTx:
Importance of Organ Failure in Recipient Selection



Cho et al. ASAIO Journal 2015; 61:139–143

Survival After HTx on MCS c or s ventilator - Experience from Korean 4 tertiary centers -

N=138

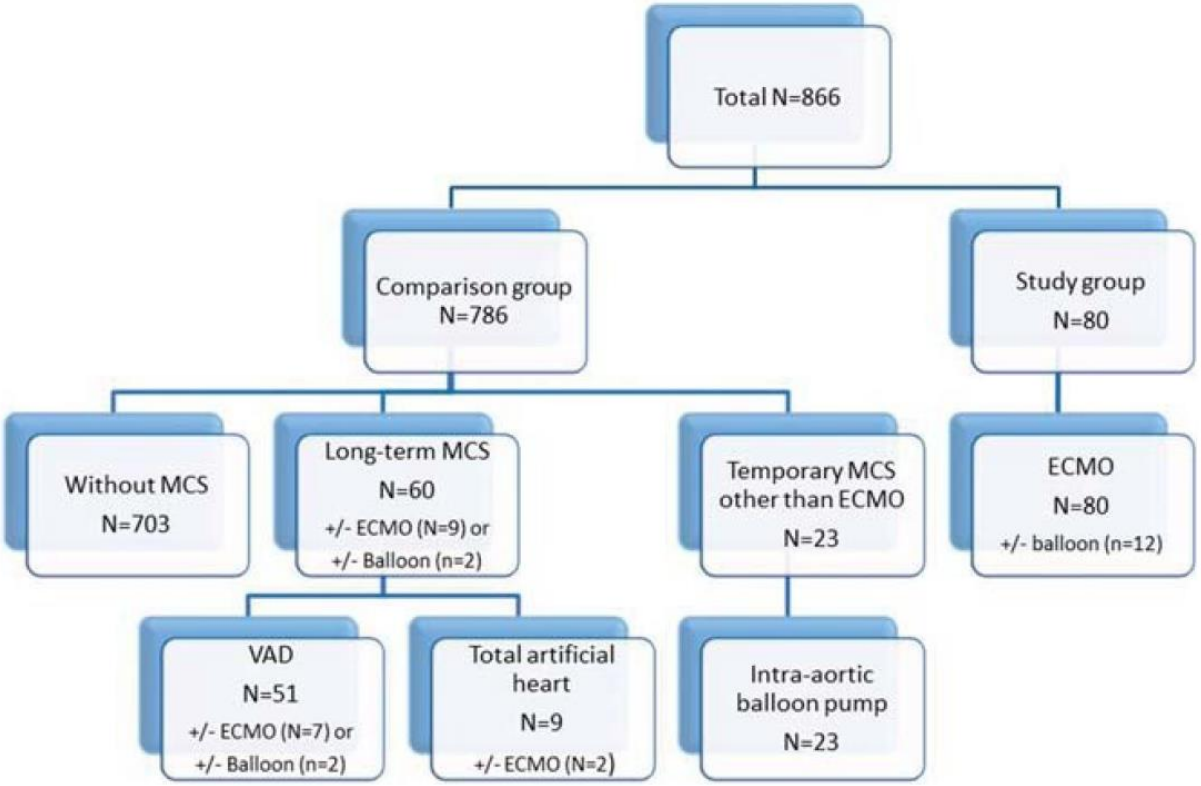


Patients at risk	0	6M	1Y	2Y	3Y	5Y
Urgency status 0	88	59	52	39	31	19
Urgency status 1	50	45	43	34	26	15

Unpublished data

Impact of Heart Transplantation on Survival in Patients on Venoarterial Extracorporeal Membrane Oxygenation at Listing in France

Carine Jasseron, PhD,[1] Guillaume Lebreton, MD,[2] Christelle Cantrelle, MS,[1] Camille Legeai, MD,[1] Pascal Leprince, MD, PhD,[2] Erwan Flecher, MD, PhD,[3] Agnes Sirinelli, MD,[4] Olivier Bastien, MD, PhD,[1] and Richard Dorent, MD[1]



Transplantation 2016;100: 1979 – 1987

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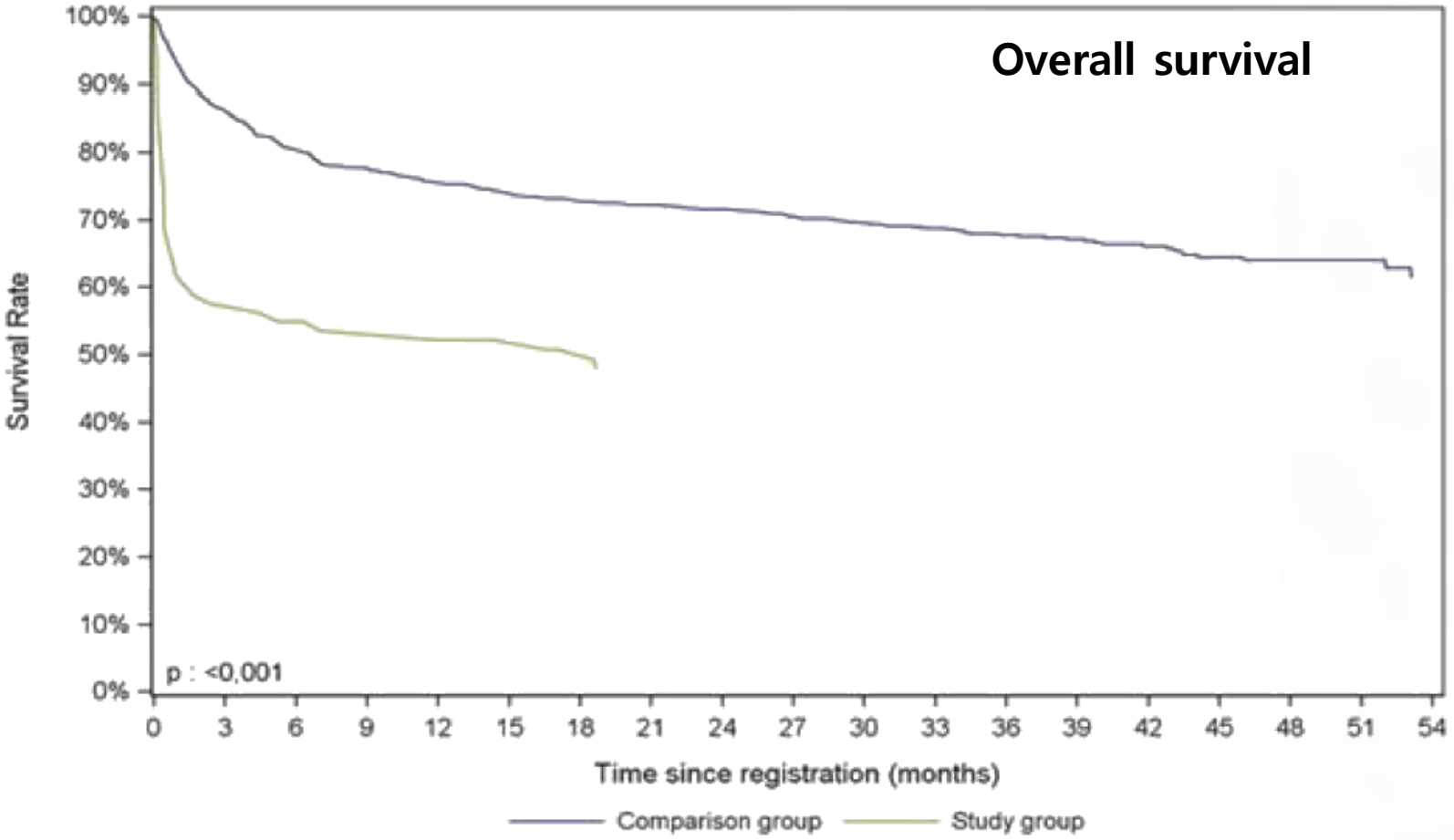

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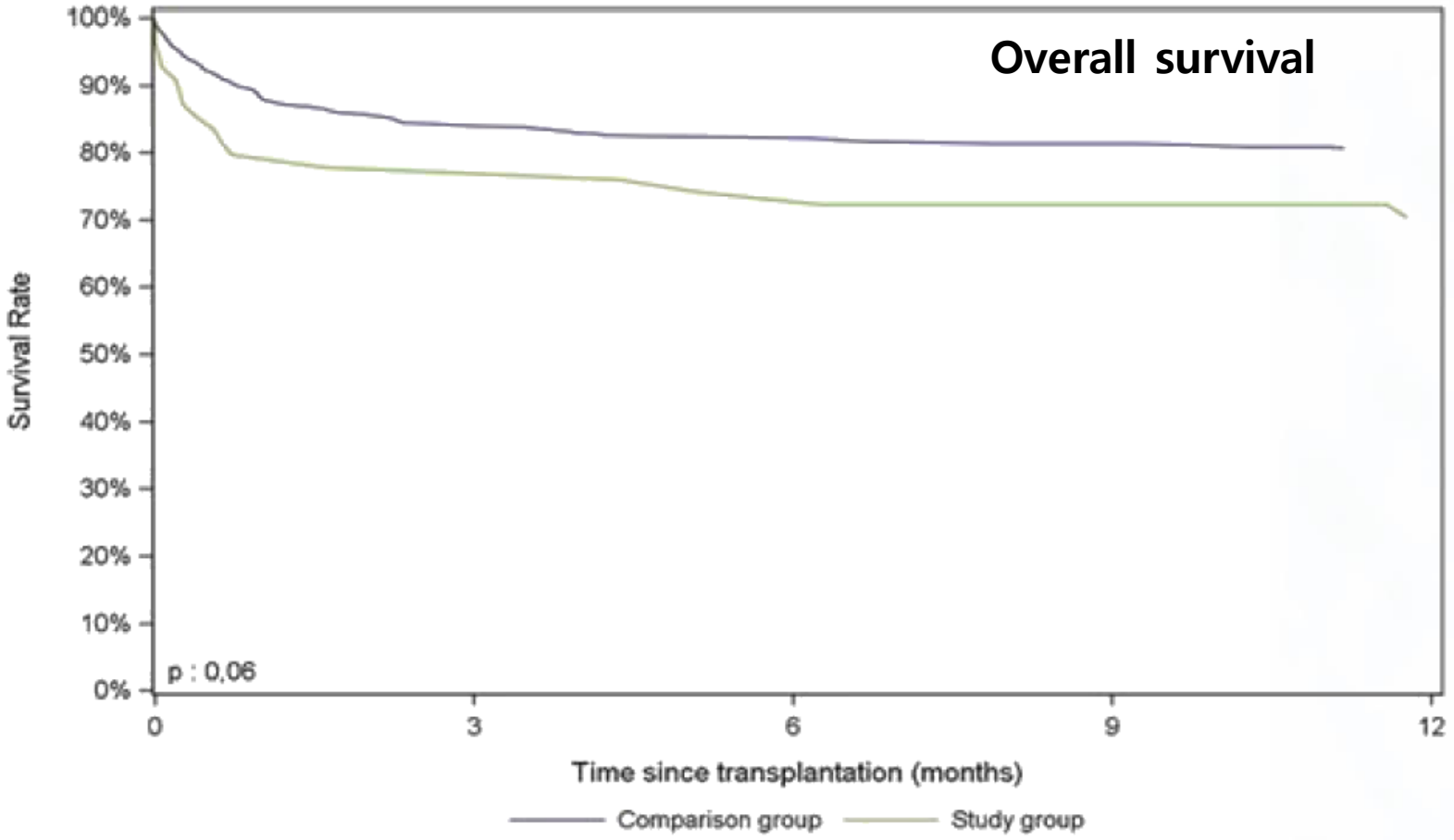

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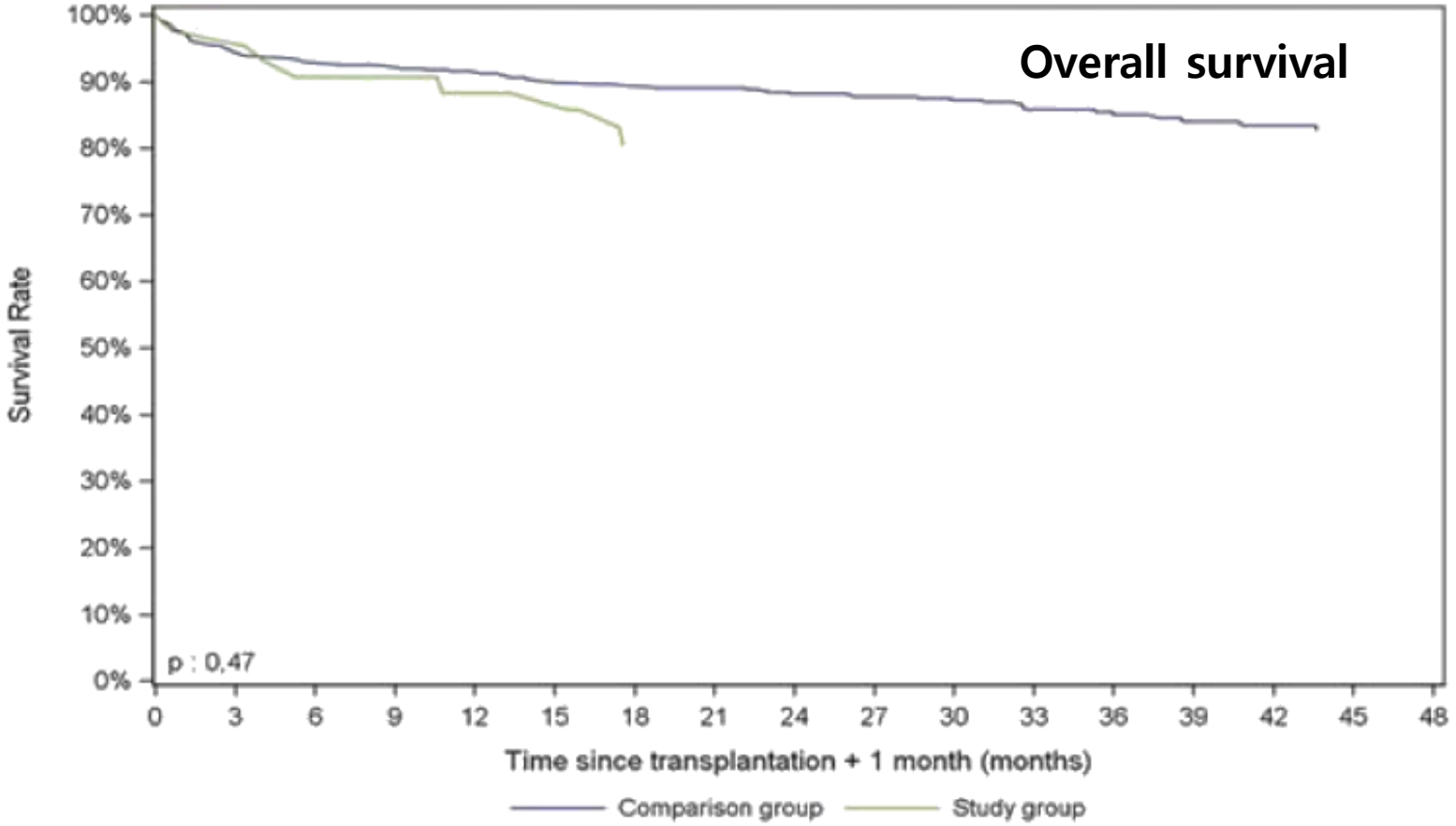

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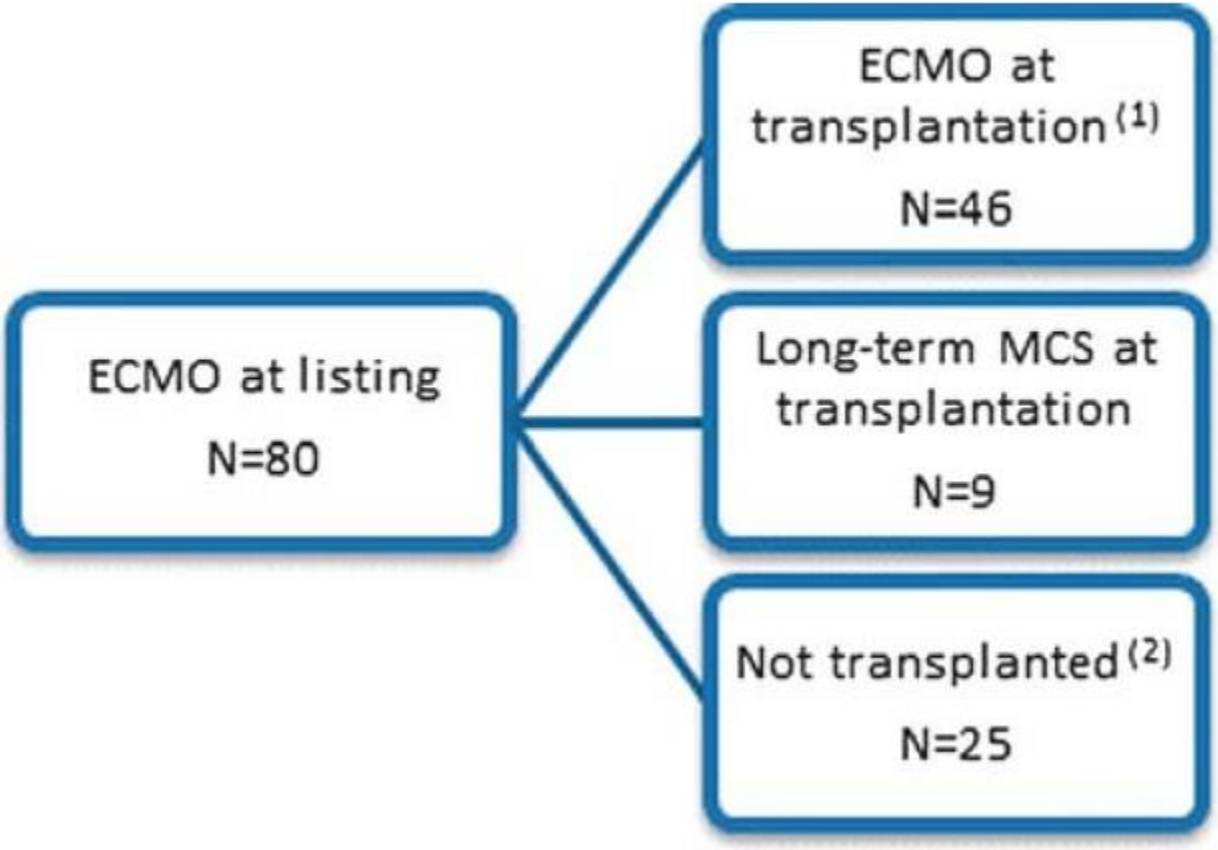

Transplantation 2016;100: 1979 – 1987

Impact of Heart Transplantation on Survival in Patients on Venoarterial Extracorporeal Membrane Oxygenation at Listing in France

TABLE 3.

Univariate and multivariate hazard ratio estimates for the risk of death after listing in candidates supported with VA-ECMO

	Univariate Analysis, N = 80			Multivariate Analysis, N = 69		
	HR	95% CI	*P*	HR	95% CI	*P*
Transplantation						
No	1	—	*P* = 0.03	1	—	0.049
Yes	0.44	(0.2-0.9)		0.44	0.2-0.9	
Age, y						
≤50	1	—	0.02	1	—	0.02
>50	2.2	1.1-4.3		2.4	1.1-5.1	
GFR	0.99	0.98-1.0	0.07	0.99	0.98-1.0	0.14
Serum bilirubin	1.01	0.99-1.01	0.1	1.01	0.998-1.01	0.18
Defibrillator						
No	1	—	0.4			
Yes	0.7	0.3-1.6				
Inotropes						
No	1	—	0.5			
Yes	1.3	0.6-3.0				
Mechanical ventilation						
No	1	—	0.3			
Yes	1.5	0.7-3.3				
Hematocrit	1.01	0.96-1.07	0.7			
ECMO duration	1.0	0.99-1.00	0.8			
Diagnosis						
	1	—	0.99			
	1.0	0.4-2.4				
Donor sex						
Male	1	—	0.98			
Female	0.98	0.4-2.8				

Transplantation 2016;100: 1979 – 1987

Impact of Heart Transplantation on Survival in Patients on Venoarterial Extracorporeal Membrane Oxygenation at Listing in France

- Patients on VA-ECMO at listing have 52% survival 1 year after listing due primarily to a high rate of death on waiting list.
- Although post-HTx survival tends to be inferior in listed patients on VA-ECMO, transplantation provided a survival benefit for VA-ECMO group.

Transplantation 2016;100: 1979 – 1987

HTx Bridged by VA-ECMO in the Adults : Experience from SMC

- From December 2003 to July 2016
- 183 heart transplants
- Excluded patients under 18 years-old

- ECLS group (n=54) :
  - Patients who had HT during ECLS.

HTx Bridged by VA-ECMO in the Adults : Experience from SMC

	ELCS (n=54)	no-ECLS (n=129)	*p* value
Recipient age	44.7±15.52	51.0±13.33	0.011
Donor age	38.5±11.84	39.6±11.42	0.555
Total ischemic time	200.0±77.79	198.3±61.25	0.878
ACC time	99.1±24.38	99.0±33.49	0.986
CPB time	170.6±39.82	169.0±60.03	0.868

- In ECLS group, the mean duration of ECLS before heart transplantation was 12.6 ± 13.33 day.
  (range, 1-65; median, 9)

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HTx Bridged by VA-ECMO in the Adults : Experience from SMC

30-day Mortality: 6% **multivariable analysis**

	HR	95% CI	P value
Age	1.046	0.993-1.102	0.091
Ischemic time	0.997	0.987-1.008	0.624
Total Bilirubin	1.092	1.016-1.174	0.017
Ventilator	0.979	0.074-13.037	0.987
Dialysis	1.492	0.260-8.567	0.654
ECLS group	2.204	0.166-29.201	0.549

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HTx Bridged by VA-ECMO in the Adults : Experience from SMC

Overall Mortality: multivariable analysis

	HR	95% CI	P value
Age	1.018	0.996-1.040	0.102
Ischemic time	0.996	0.991-1.000	0.077
Total Bilirubin	1.041	0.992-1.092	0.104
Ventilator	0.332	0.104-1.063	0.063
Dialysis	1.231	0.492-3.078	0.657
ECLS group	3.481	1.134-10.683	0.029

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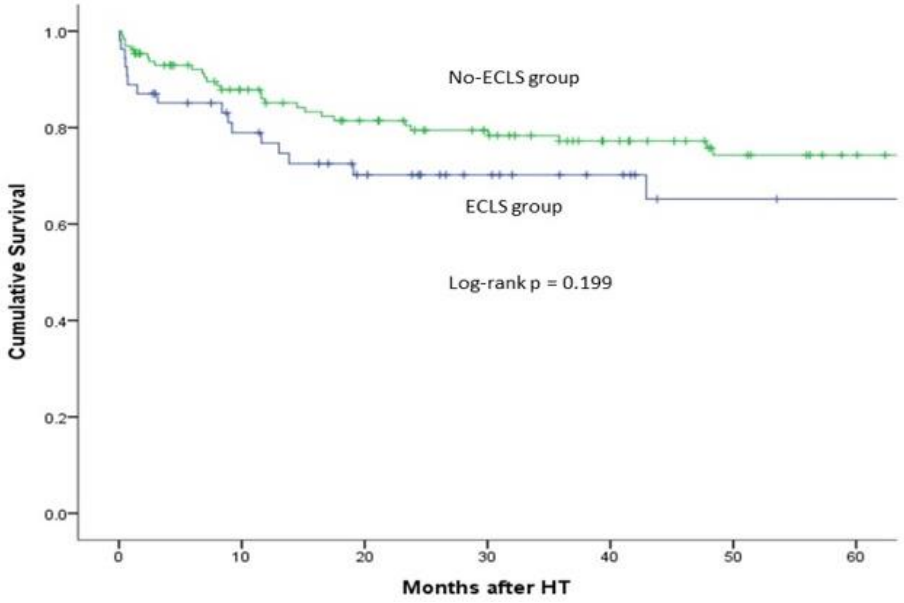
HTx Bridged by VA-ECMO in the Adults : Experience from SMC

Overall survival

	12 month	24 month
ECLS group	85.1%	70.2%
No-ECLS group	94.5%	89.5%



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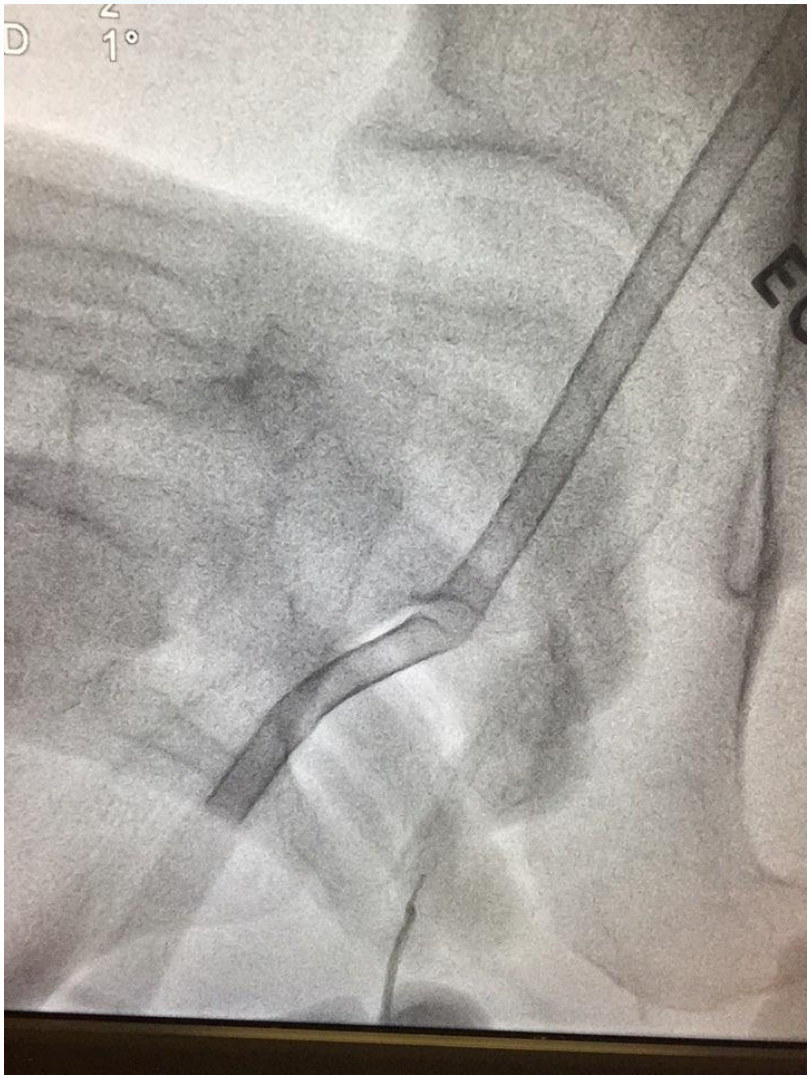
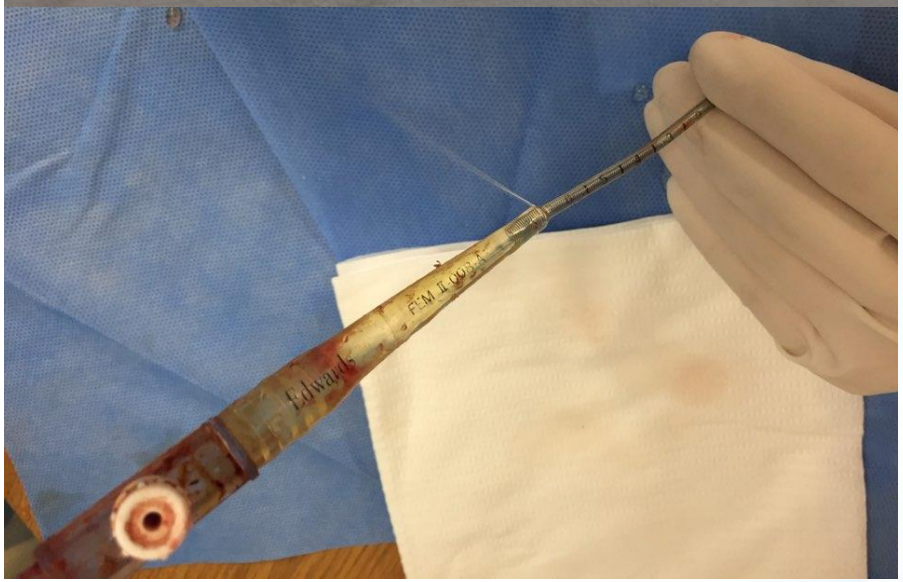
Conclusion

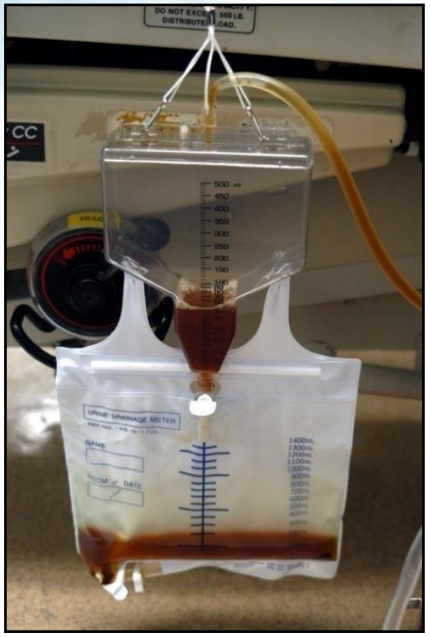
- Although survival after HTx on VA-ECMO was reasonably good, VA-ECMO was a predictor of poor outcome
- Considering relatively short waiting time for status 0 in Korea, ECMO as a bridge to HTx is a viable option
- Longer waiting time for HTx
- LVAD bridging be mandatory in near future

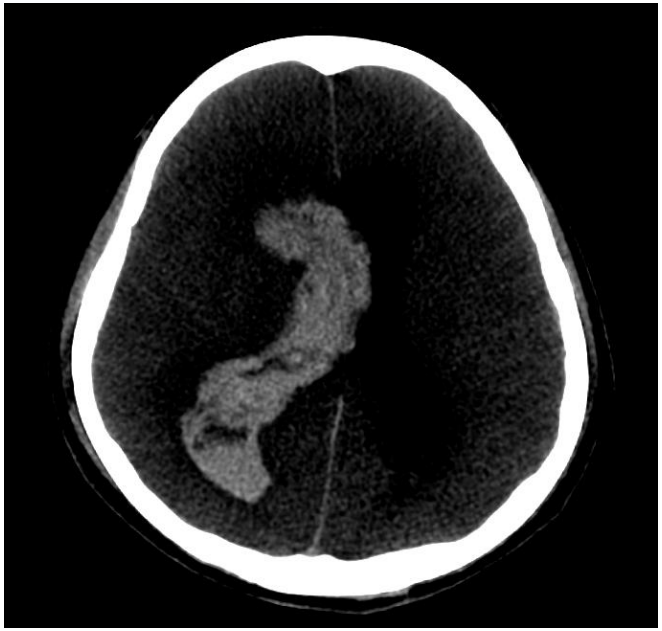
Limb ischemia

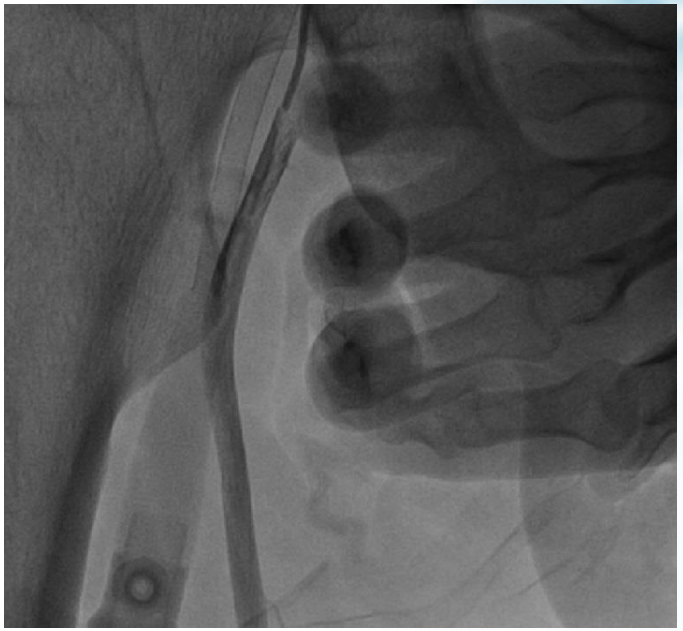
Cannula related complications

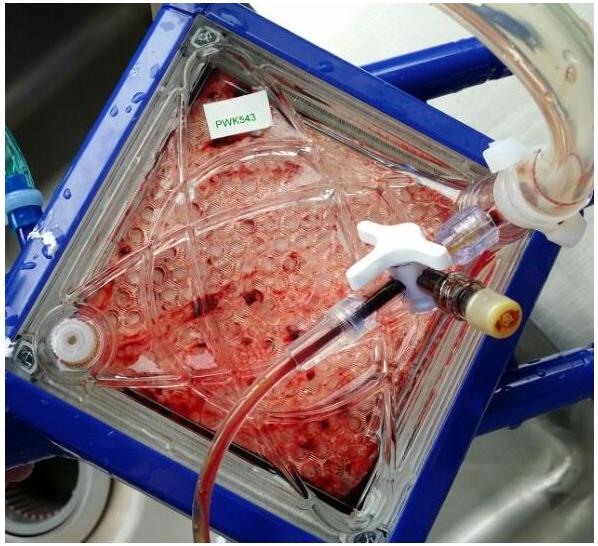








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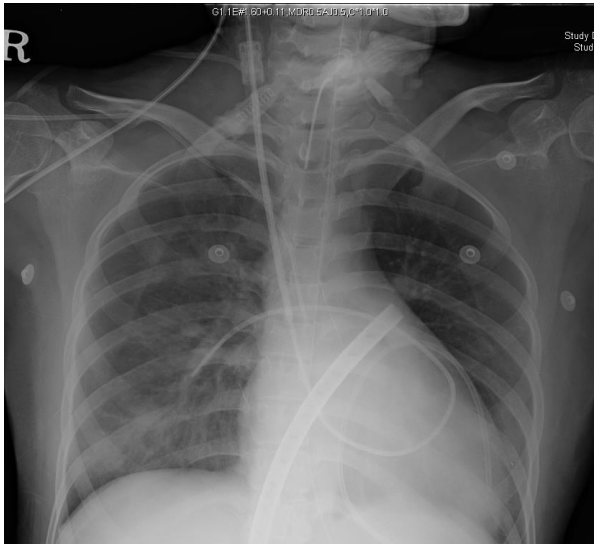

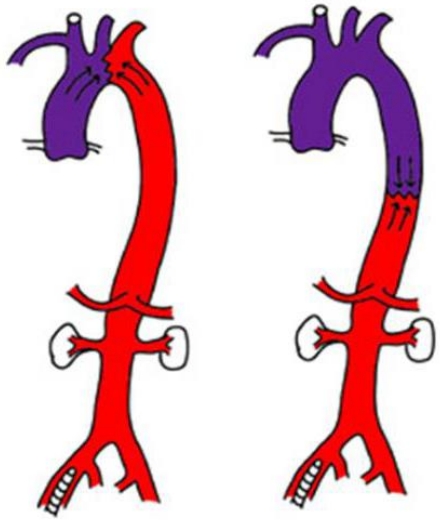

Take Home Message

- Management of critically-ill patients
- ECMO-related complications

- Experienced multidisciplinary teams

- Patients should be referred to transplant centers with ECMO experiences early in their course