ECMO role in Heart Transplant

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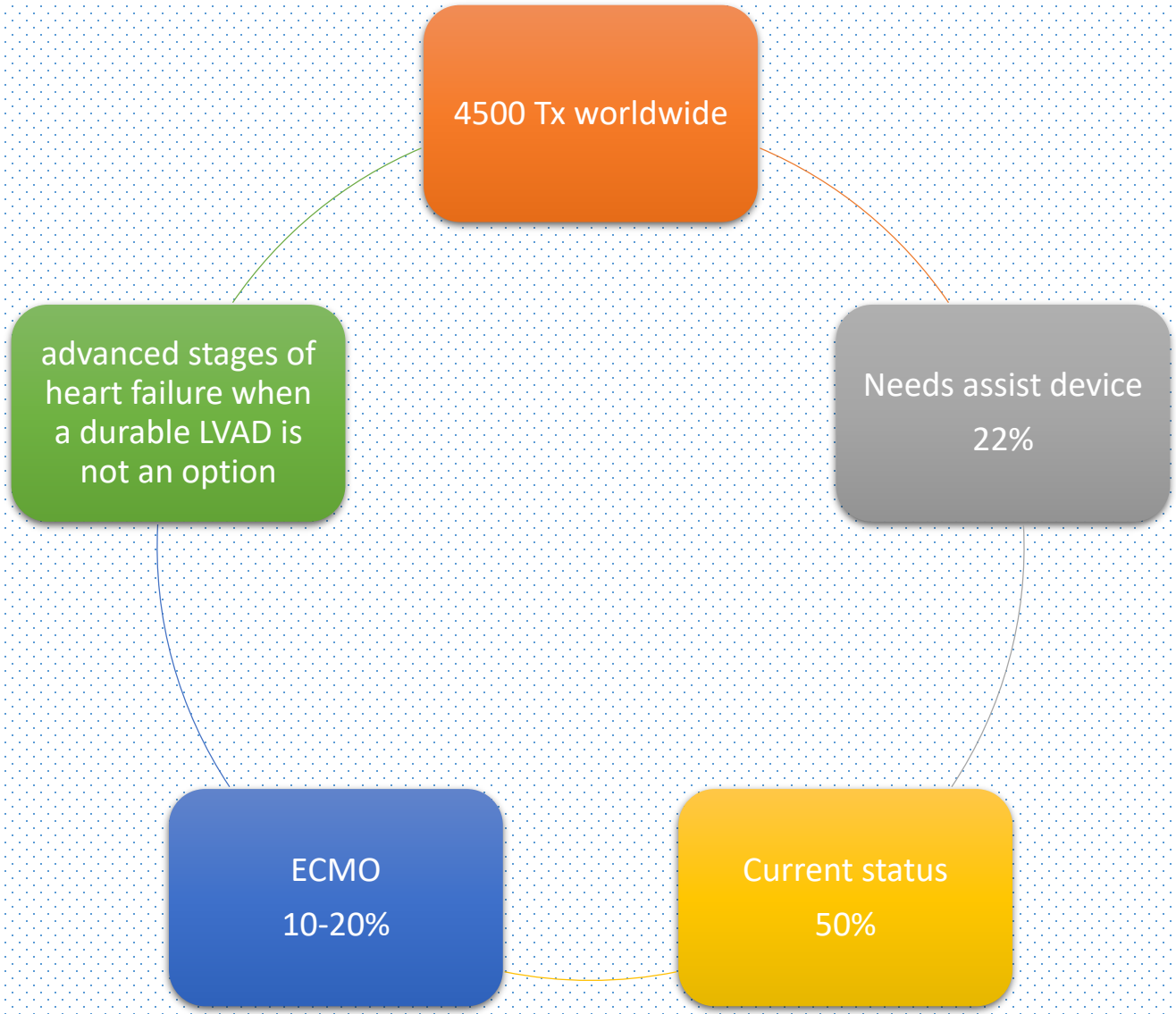
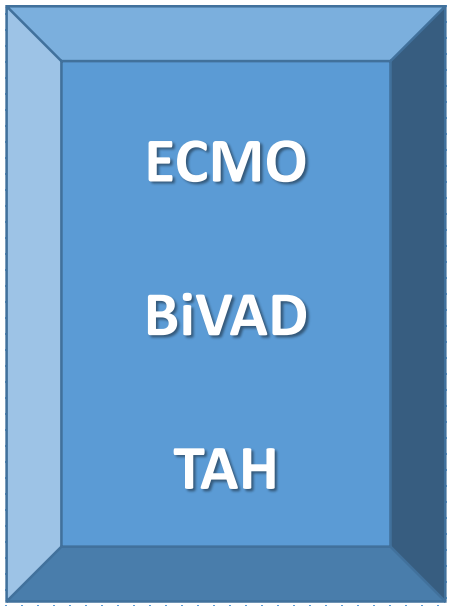
Dec, 2019

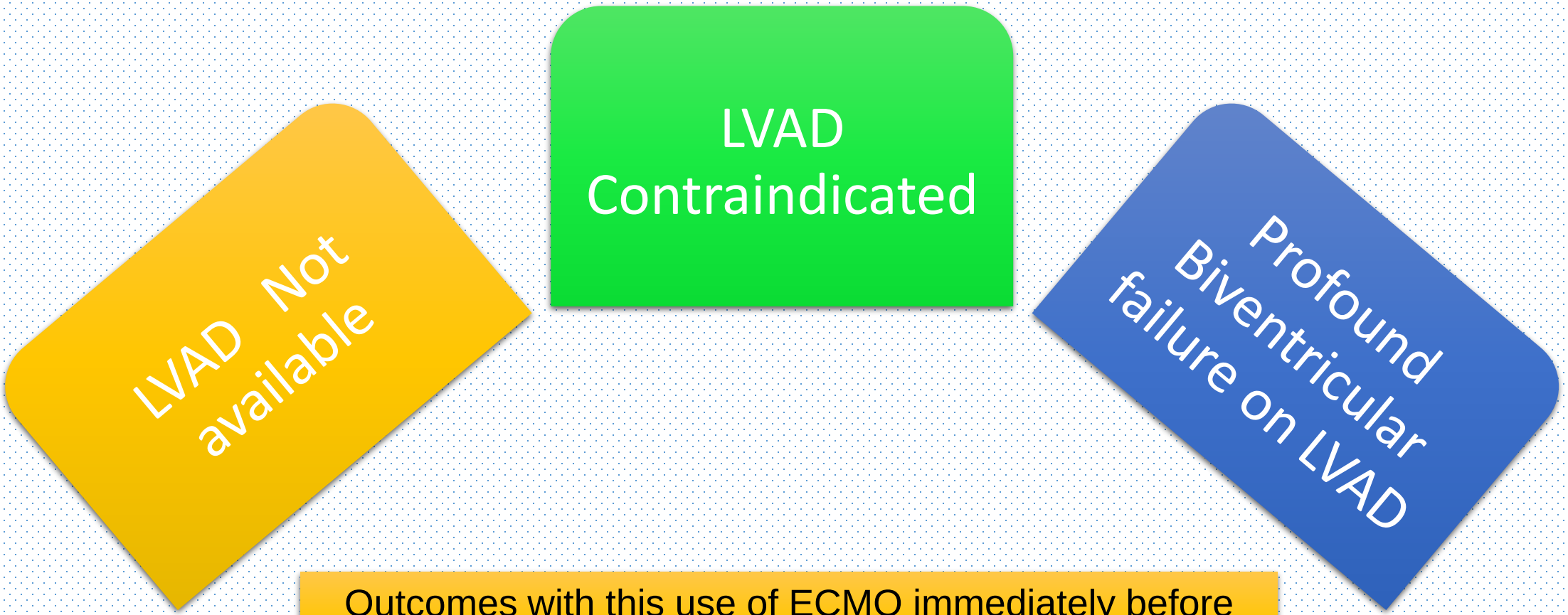

4500 Tx worldwide
Needs assist device
22%
Current status
50%
ECMO
10-20%
advanced stages of heart failure when a durable LVAD is not an option

INTERMACS I: “crash and burn”,
refers to patients in cardiogenic shock, with critical hypotension despite inotropic support and established organ hypoperfusion.



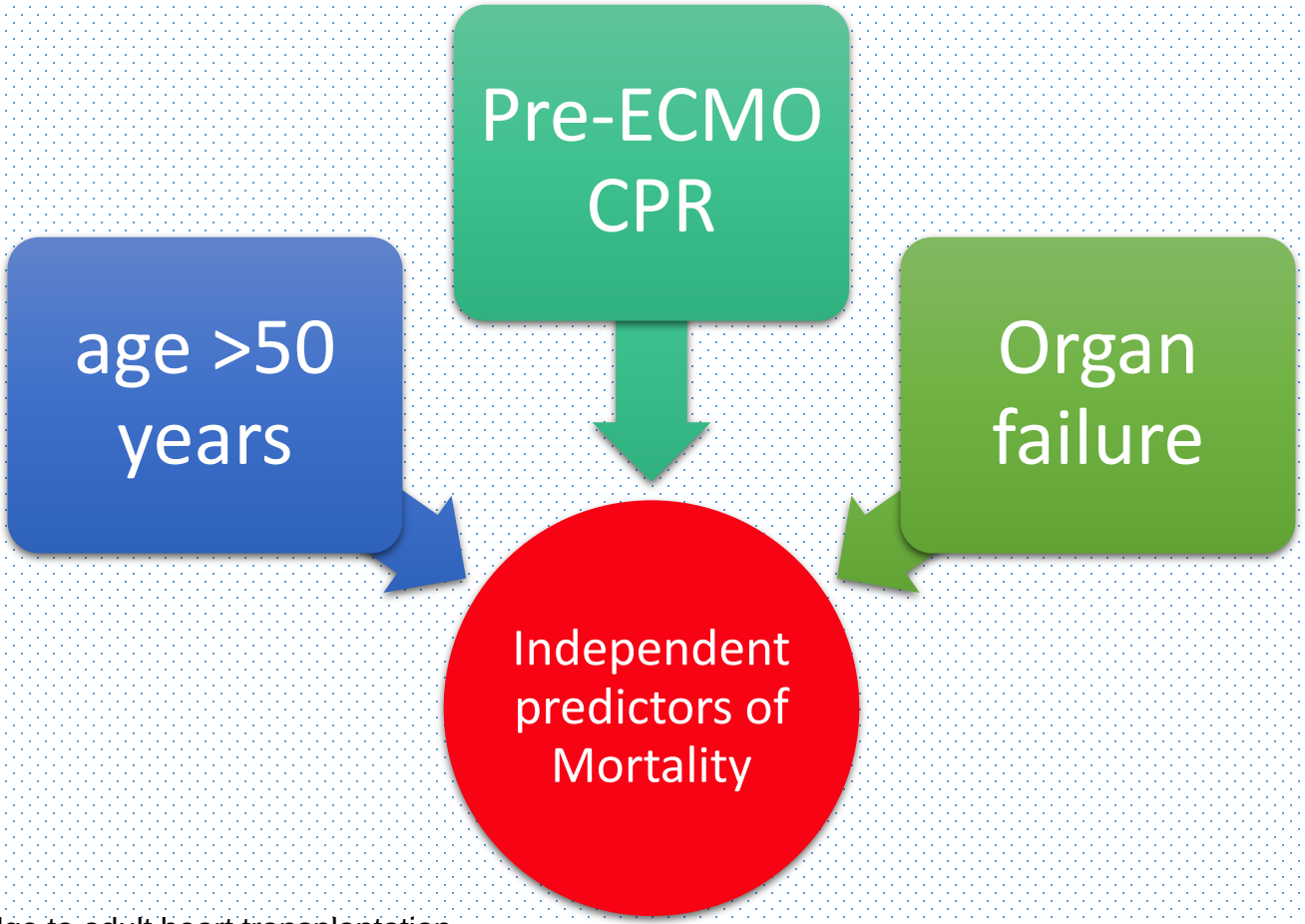
ECLS is insufficient to revert the ongoing multiorgan dysfunction syndrome

ECMO prior to heart transplant



Outcomes with this use of ECMO immediately before heart transplant have been modest with variable results

ECMO as Bridge to TX: 44%



Chung JC, Tsai PR, Chou NK, et al.
Extracorporeal membrane oxygenation bridge to adult heart transplantation.
Clin Transplant 2010;24:375-80.

French National Registry (CRISTAL)

The 1-year overall survival rate was candidates on ECMO (52.2%) as compared with patients who did not require ECMO support (75.5%)

TX provides a survival benefit in listed patients on VA-ECMO even if post-transplant survival remains inferior to that of patients without VA-ECMO and that transplantation

Transplantation 2016;100:1979-87.

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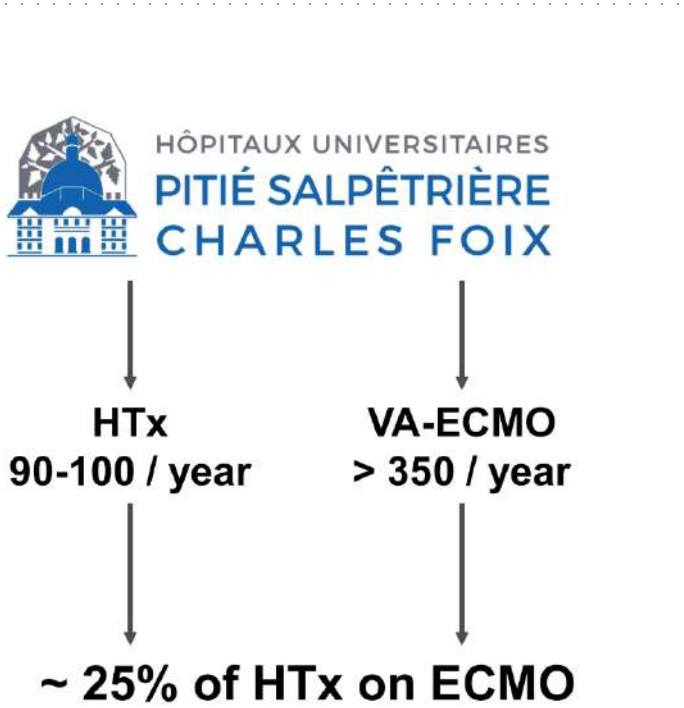
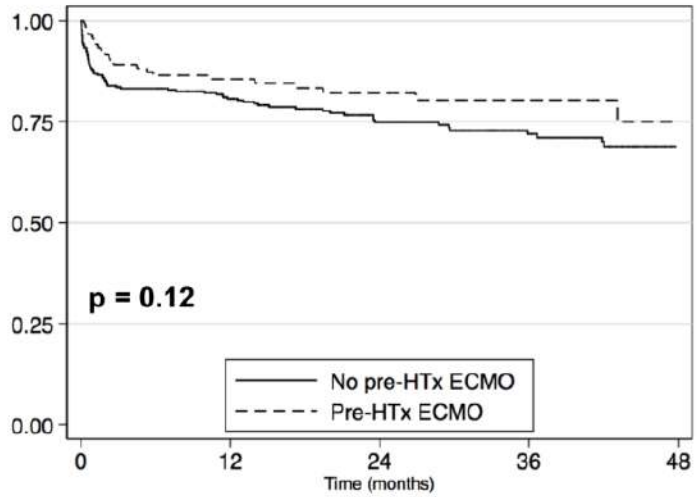


Survival after heart transplantation

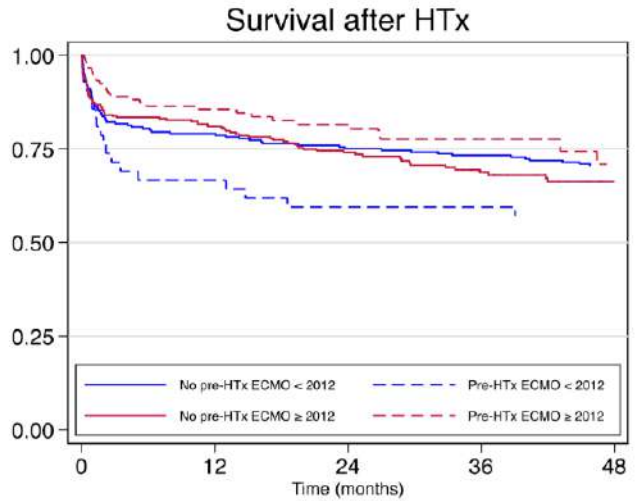
1-year survival = 82 %



Number at risk

ecmopre = No pre-HTx ECMO	297	219	126	83	38
ecmopre = Pre-HTx ECMO	118	90	55	24	11

Survival after heart transplantation



Number at risk

ecmo_date = No pre-HTx ECMO 2008-2012	225	177	168	163	157
ecmo_date = Pre-HTx ECMO 2008-2012	42	28	25	25	24
ecmo_date = No pre-HTx ECMO 2013-2016	295	209	163	102	57
ecmo_date = Pre-HTx ECMO 2013-2016	118	87	71	40	18

Increased experience with (ECMO) as a mode of cardiac support has expanded its use

The use of ECMO is associated with acceptable outcomes in well-selected patients.

While outcomes with (ECMO) as a bridge to heart transplant have been variable, several series have confirmed the safe use of ECMO to stabilize patients prior to (LVAD) implantation.

When ECMO is used prior to heart transplant, mortality is greatest during the first 6 months post-Tx.

Patients who are alive 6 months after transplant appear to have similar survival rates as patients who were not supported with ECMO prior to transplant.

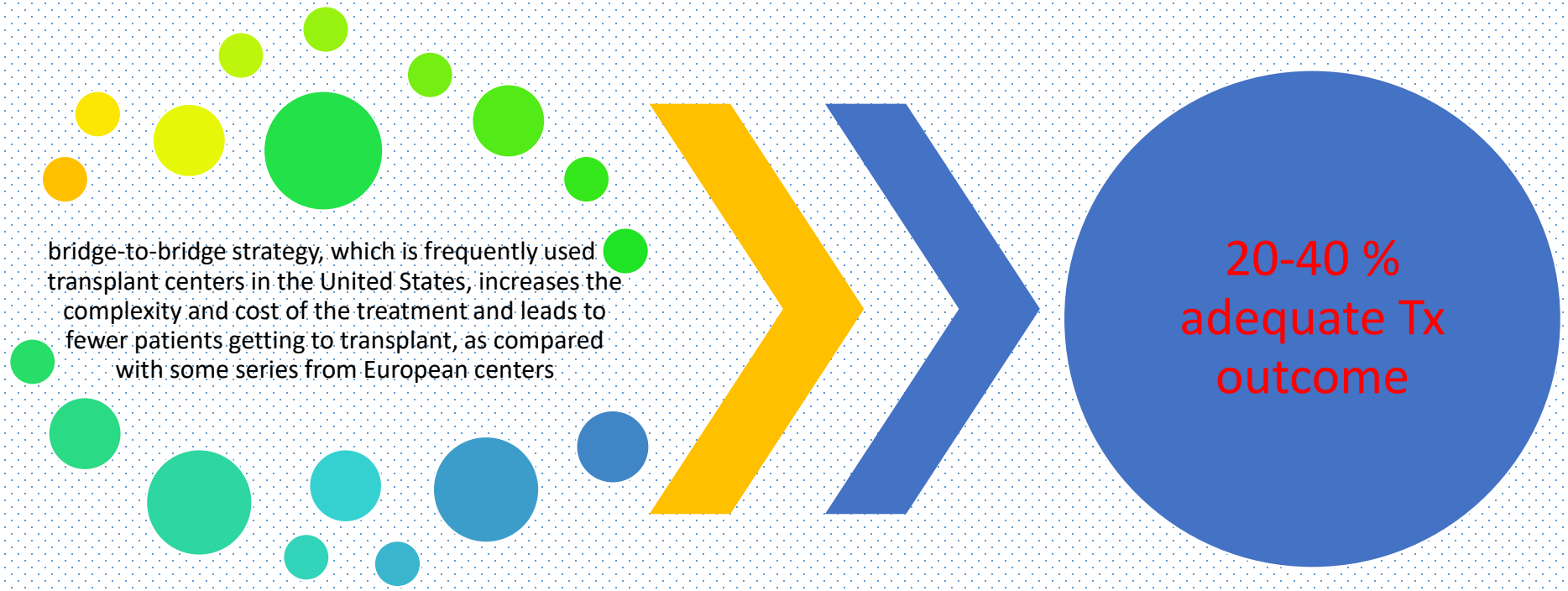
Survival with this double-bridge strategy has varied according to the patients selected, ranging from **30–80% survival** after LVAD placement

LVAD is not an ideal option

- Sever LVH
- Refractory ventricular arrhythmias
- Severe biventricular dysfunction
- Congenital heart disease

Ann Transl Med 2017;5(20):398

Bridge to Bridge strategy



ECMO in Children

Twice Mortality

- The largest group of patients who receive pre-transplant ECMO.
- The lack of a pediatric VAD
- Frequent anatomical variations in patients with congenital heart abnormalities limit the consideration of LVAD support in pediatric patients
- 16% of pediatric, heart-transplant recipients receive ECLS while awaiting transplantation

30% death in 30 days

40% likelihood of TX

Post-Transplant ECMO

The most significant complication in the immediate post-operative period is early graft failure (EGF), with a mean incidence of 20–25%.

EGF is a major risk factor for death and accounts for 40–50% of early mortality after HTx.

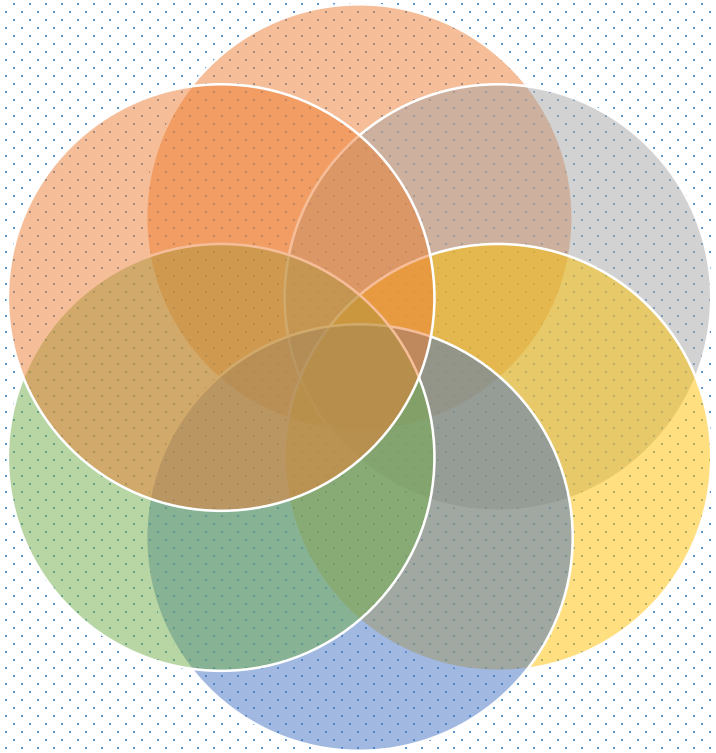
Despite the use of inotropes, EGF may persist and require temporary mechanical circulatory support.

Considering short-term outcomes, 45–80% of patients were discharged alive from hospital.

Ann Cardiothorac Surg 2019;8(1):99-108

(ECMO) has been has proved to be a reliable strategy in patients with EGF after HTx.

ECMO-treated EGF, among survivors, has no detrimental effect for graft function.



Duration of support is variable, with a mean duration of 4–8 days.

Considering long-term outcomes, ECMO survivors appear to have similar survival rates to HTx patients who did not experience EGF.

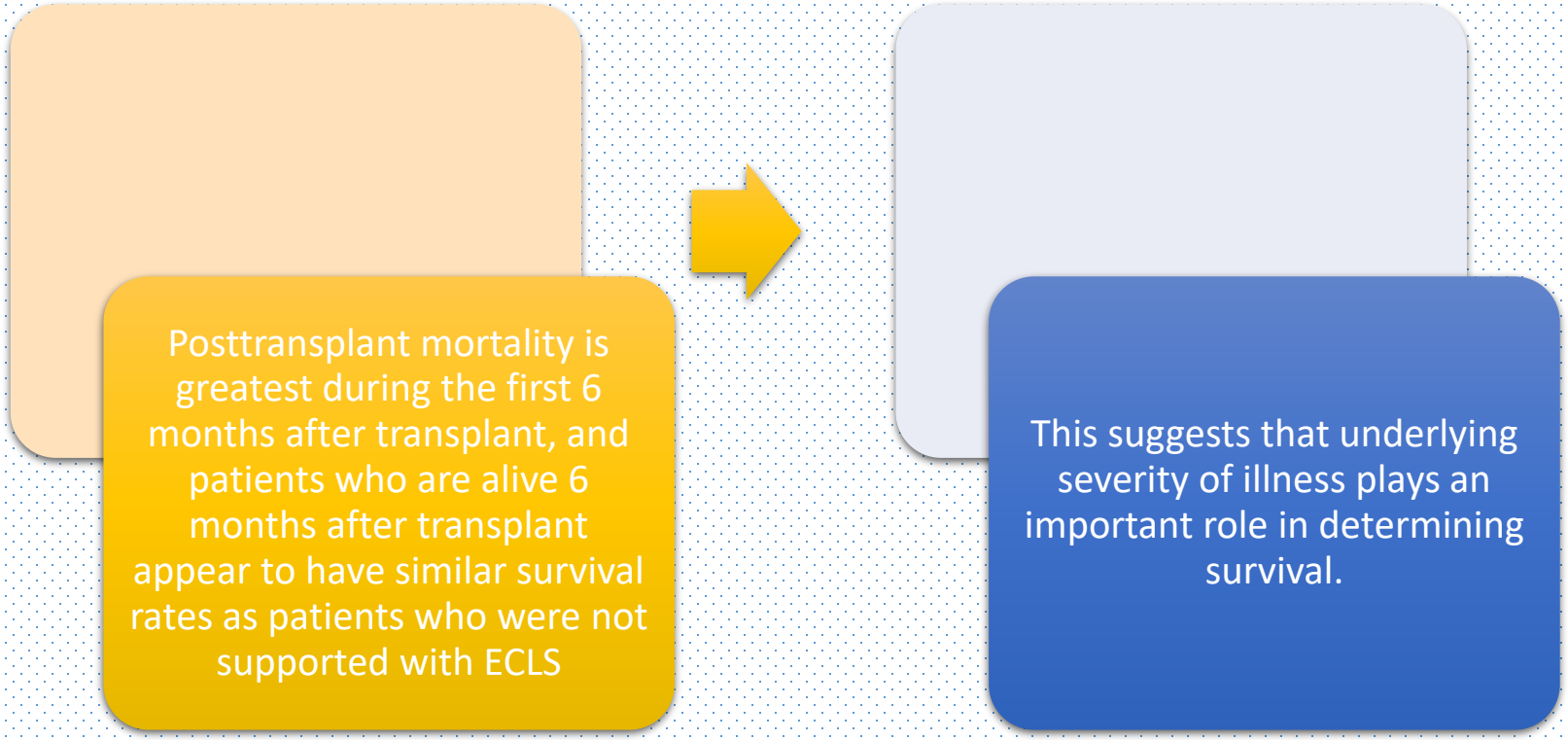
Cannulation strategy and device selection have no differences with respect to short-term outcomes.

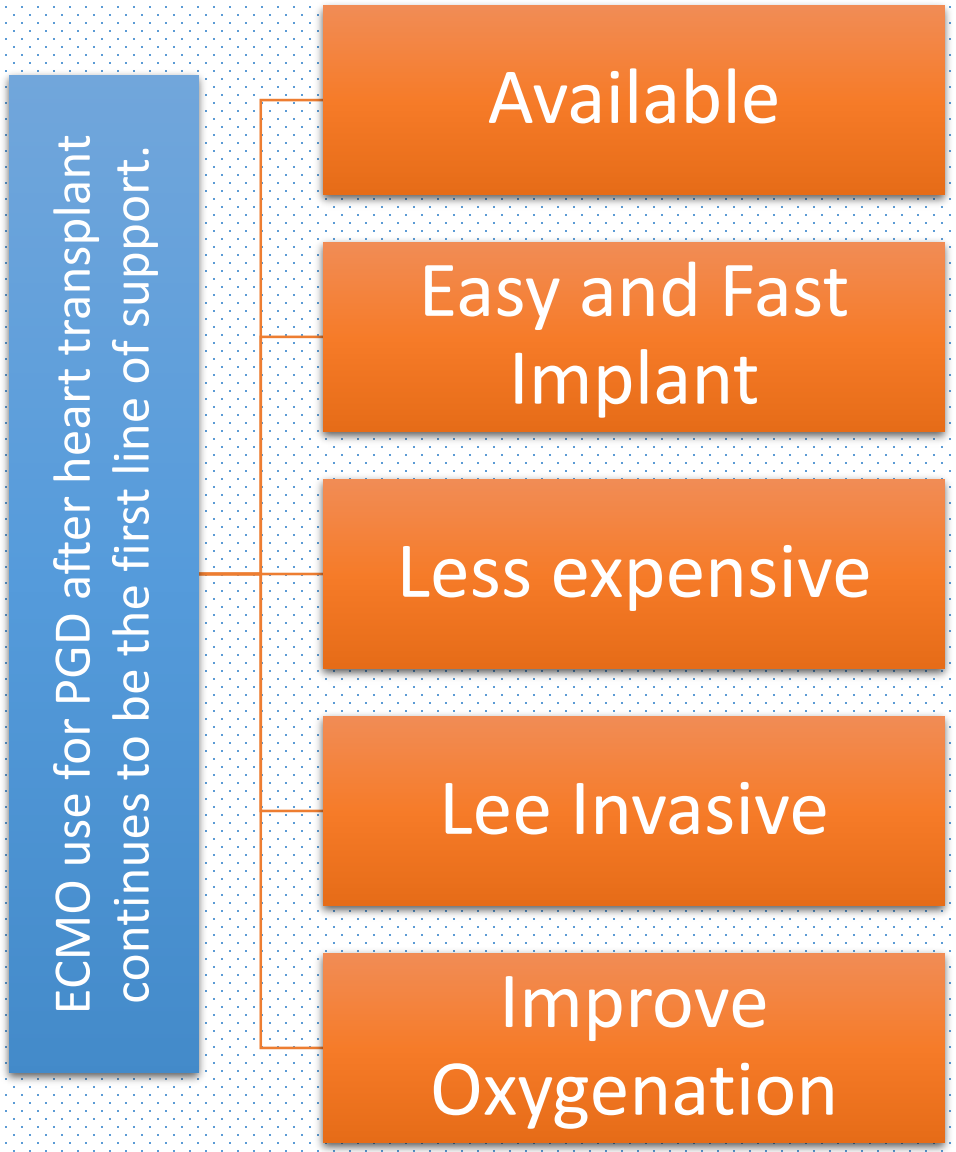
The main causes of death are multi-organ failure, bleeding, heart failure, stroke and sepsis.

ECMO

is a reliable therapeutic option to support patients with severe graft failure after HTx, providing adequate support

Either central or peripheral arteriovenous cannulation.

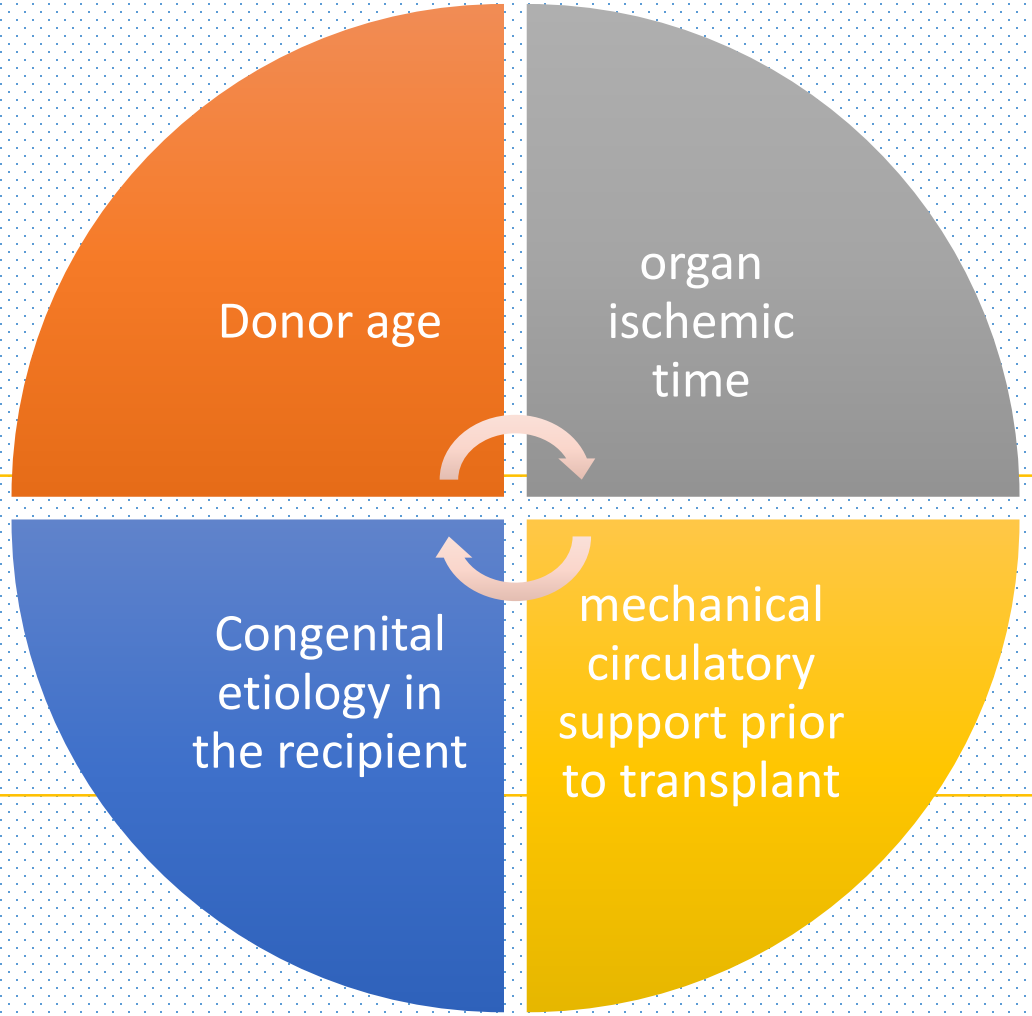

Posttransplant mortality is greatest during the first 6 months after transplant, and patients who are alive 6 months after transplant appear to have similar survival rates as patients who were not supported with ECLS
This suggests that underlying severity of illness plays an important role in determining survival.


ECMO use for PGD after heart transplant continues to be the first line of support.
Available
Easy and Fast Implant
Less expensive
Lee Invasive
Improve Oxygenation

ECMO after heart transplant

PGD Incidence: 3–30%

PGD accounts for 40–50% early mortality of TX



Classified severe PGD as a need for mechanical circulatory support (other than an intra-aortic balloon pump) to maintain adequate end-organ perfusion following the procedure.

The device of choice and timing of insertion varies among institutions

More Liberal use recommended

Although ECMO has been favored historically

Ease of implantation and the ability to provide oxygenation following a prolonged cardiopulmonary bypass,

ECMO use is associated with increased risk of bleeding and insufficient LV unloading with a risk of intracardiac thrombosis

Overall conditional survival was 73% at 1 year and 66% at 5 years.

ECMO support is a reliable therapeutic option for severe, Early graft failure

Eur J Cardiothorac Surg 2010;37:343-9

J Heart Lung Transplant. 2017 Jun;36(6):650-656. doi: 10.1016/j.healun.2016.12.006. Epub 2016 Dec 23.

Improved outcomes from extracorporeal membrane oxygenation versus ventricular assist device temporary support of primary graft dysfunction in heart transplant. Columbia University Medical Center, New York,

597 Tx patients

Severe PGD developed in 44 (7.4%).

Within 24 hours of transplant,

17 patients VAD, and 27 patients VA-ECMO support.

In-hospital mortality was 41% for VAD patients and 19% for VA-ECMO patients.

Ten patients (59%) were weaned from VAD support, and 24 patients (89%) were weaned from VA-ECMO support after adequate graft function recovery.

The 3-year post-transplant survival was 41% in the VAD group and 66% in the VA-ECMO group

severe PGD, support with VA-ECMO appears to result in better clinical outcomes than VAD support

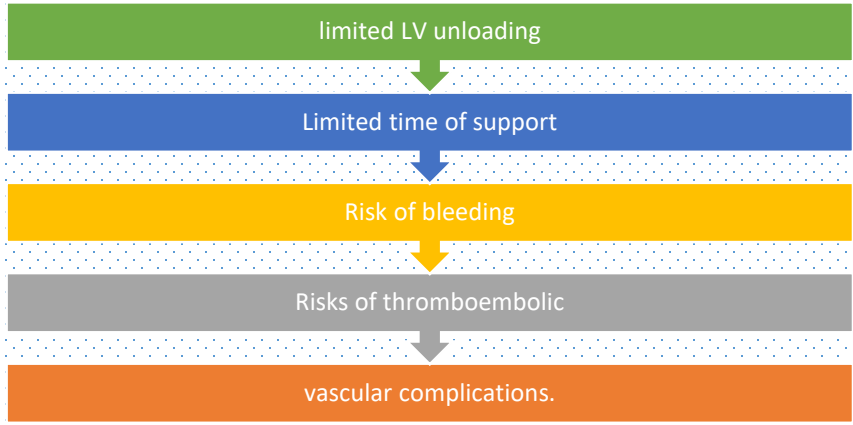
Review Article

Extracorporeal life support in preoperative and postoperative heart transplant management

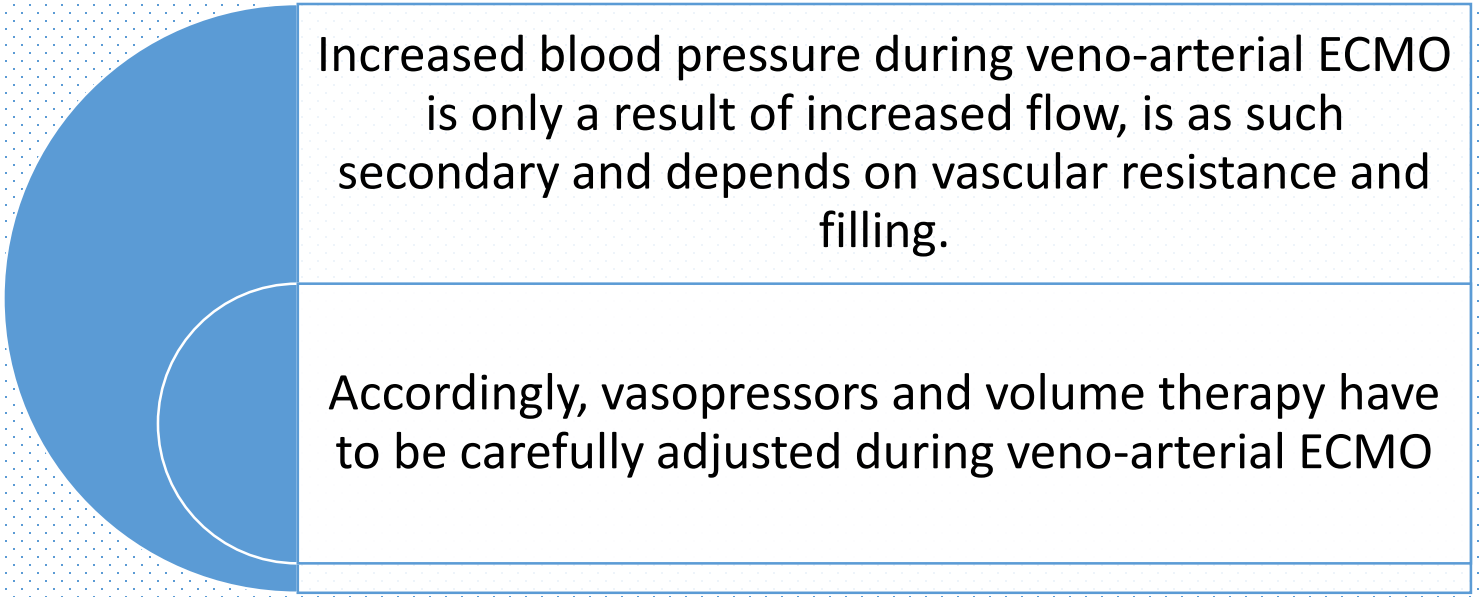
Christian A. Bermudez[1], D. Michael McMullan[2]

Tran and colleagues, from UCLA, demonstrated that patients requiring ECMO for heart transplant graft failure had lower mortality (51.6%) as compared with patients who required ECMO support for all other etiologies (69.1%).

Although ECMO can provide adequate support, it has limitations



ECMO & BLOOD PRESSURE



Cannulation technique, tips & site?

Approach

- Veno arterial VA
- Veno-venous VV

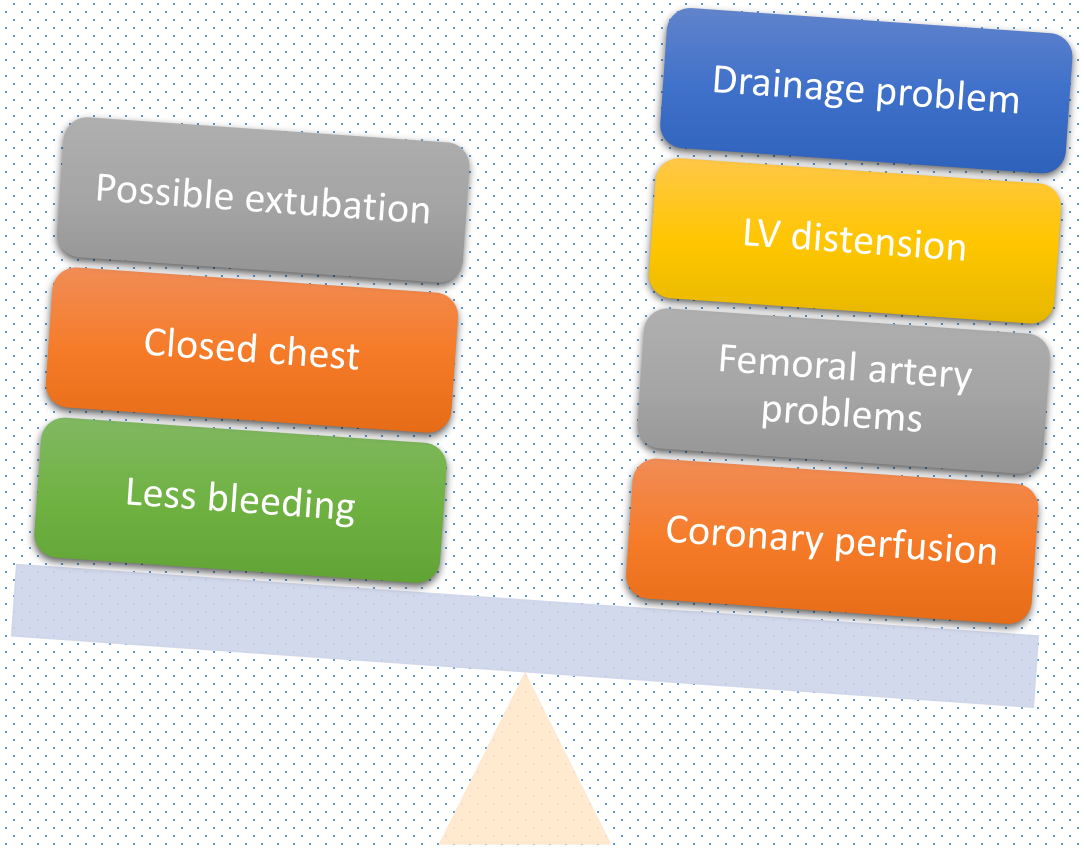
Site

- Central
- Peripheral

Peripheral
VA ECMO

Advantage

Disadvantage



VA ECMO drawbacks

Distal perfusion

Arterial line

Blood pressure

watershed

LV distention & Afterload mismatvh Pulmonary congestion (Low EF & AI)

Limb Ischemia

Triple cannulation

Veno-veno-arterial cannulation

In some patients on veno-arterial ECMO respiratory function is not sufficient which potentially results in upper body hypoxemia, also referred to as differential hypoxia, two-circulation syndrome or harlequin syndrome

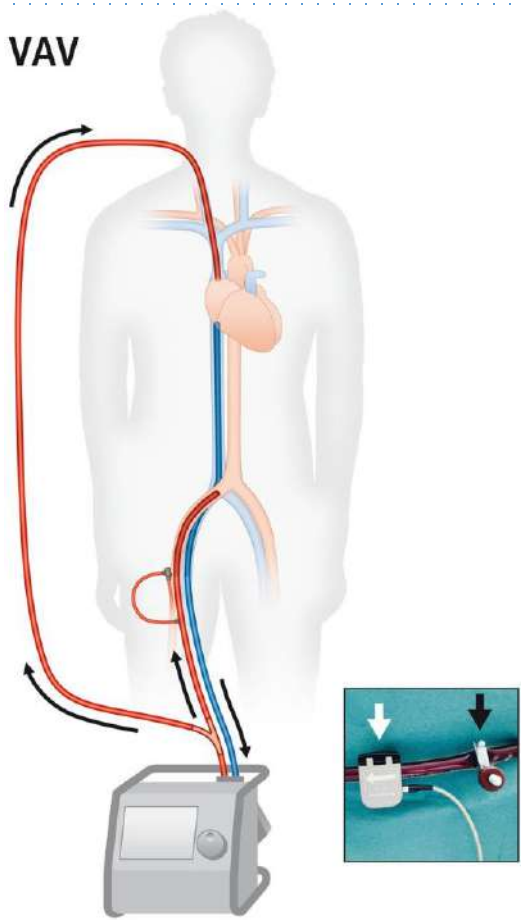
This phenomenon may further occur in very large patients supported with standard sized cannulae.

Triple cannulation (two for drainage and one for supply), which is sufficient to disrupt dual circulation in many cases.

Triple cannulation

potent respiratory and circulatory support at the same time

Veno-arterial-venous cannulation



Shekar et al. Critical Care 2014, 18:219
http://ccforum.com/content/18/2/219

CRITICAL CARE

REVIEW

Extracorporeal life support devices and strategies for management of acute cardiorespiratory failure in adult patients: a comprehensive review

Kiran Shekar[1*], Daniel V Mullany[1], Bruce Thomson[1,2], Marc Ziegenfuss[1], David G Platts[1,3] and John F Fraser[1]

Table 2 Extracorporeal life support strategies for mechanical circulatory support in isolated cardiac failure

ECLS strategy	Principle indication(s)
VA ECMO (return femoral artery)	Default strategy for potentially reversible cardiogenic shock of any cause
Central VA ECMO (return aorta)	Failure to wean from cardiopulmonary bypass where recovery expected within 7 days
	Salvage for small patients with cardiogenic shock where femoral arterial access inadequate
VA ECMO (return axillary artery)	Reversible cardiogenic shock where high flows not required
	Reversible cardiogenic shock with lower-limb vascular disease
Centrimag™ (Levitronix LLC, Waltham, MA, USA) LVAD (access left atrium/left ventricle, return aorta)	Isolated LV support where recovery is expected in 8 weeks
Centrimag™ (Levitronix LLC) RVAD (access right atrium, return pulmonary artery)	Isolated RV support where recovery is expected in 8 weeks
Centrimag™ (Levitronix LLC) BiVAD	Biventricular support where recovery is expected in 8 weeks
TandemHeart (CardiacAssist, Inc., Pittsburgh, PA, USA) percutaneous LVAD (access left atrium via femoral vein, return femoral artery	Isolated LV support
Impella™ (Abiomed, Aachen, Germany) percutaneous LVAD (access femoral artery)	Isolated LV support
Peripheral VA ECMO + Impella™ (Abiomed) percutaneous LVAD	Isolated LV support with better LV decompression
Implantable LVAD + temporary RVAD (±oxygenator)	Met criteria for LVAD but unexpected reversible RV dysfunction occurred

BiVAD, biventricular assist device; ECLS, extracorporeal life support; ECMO, extracorporeal membrane oxygenation; LV, left ventricular; LVAD, left ventricular assist device; RV, right ventricular; RVAD, right ventricular assist device; VA, venoarterial.

Patient selection criteria for ECMO

Hypoxic respiratory failure indications

- Acute respiratory distress syndrome due to any cause
- Bridge to lung transplant
- Primary graft failure of lung transplant
- $Pa_{O_2}/Fi_{O_2} < 150$ while the patient is receiving $Fi_{O_2} > 90\%$ and high positive end-expiratory pressure (15–20 cm H_2O)
- Murray score ≥ 2
- Inability to maintain airway plateau pressure ≤ 30 cm H_2O

Hypercapneic respiratory failure indications

- Exacerbation of chronic obstructive pulmonary disease
- Status asthmaticus
- $Pa_{CO_2} > 80$ mm Hg
- pH < 7.15
- Airway plateau pressure ≤ 30 cm H_2O

Cardiac failure indications

- Myocardial infarction-associated cardiogenic shock
- Fulminant myocarditis
- Sepsis-associated myocardial depression
- Extracorporeal cardiopulmonary resuscitation
- Postcardiotomy or post-heart transplant cardiogenic shock
- Primary graft failure after heart transplant
- Bridge to ventricular assist device implantation or heart transplant

Absolute contraindications

- Uncontrolled active hemorrhage
- Terminal illness
- Irreversible or end-stage heart or lung failure in patients who are not candidates for transplant

Relative contraindications

- More than 7 days on mechanical ventilation with high Fi_{O_2} or high-pressure ventilation
- Nonpulmonary organ dysfunction, especially renal failure
- Irreversible central nervous system dysfunction
- Malignancy, solid-organ transplant, or immunosuppression
- Conditions precluding use of anticoagulation
- Advanced age
- Weight > 125 kg

Extracorporeal Membrane Oxygenation Support After Heart Transplantation in Children—Outcomes of a Single Center Cohort

Nair, Asha G. MD[1,2]; Sleeper, Lynn A. ScD[1,2]; Smoot, Leslie B. MD[1,2]; Wigmore, Daniel BS[1,2]; Mecklosky, Jessica BS[1]; Andren, Kristofer BS[1]; Bastardi, Heather J. CPNP, RN[1]; Blume, Elizabeth D. MD[1,2]; Fynn-Thompson, Francis MD[3,4]; Thiagarajan, Ravi R. MD[1,2]; Alexander, Peta M. A. MBBS[1,2]

Pediatric Critical Care Medicine: October 28, 2019 - Volume Online First - Issue - p

246 heart transplants

50 ECMO

28 Early 22 Late graft failure

59% hospital discharge

One year survival 55% in early 40% in late

One year Mortality predictors

Congenital heart disease

Renal dysfunction

Elevated pulmonary vascular resistance

ECMO late after heart transplantation

J Card Surg. 2019 Oct 14. doi: 10.1111/jocs.14274.

Primary graft dysfunction after heart transplantation: Outcomes and resource utilization.
Division of Cardiothoracic Surgery, Virginia Commonwealth University, Richmond, Virginia.

718 heart transplants (2001-2016)

110 (15.3%) PGD

88% IABP 17 % ECMO 3% Impella

Mortality (31.8% vs 3.8%, P < .0001).

J Artif Organs. 2019 Nov 11. doi: 10.1007/s10047-019-01146

A case series: the outcomes, support duration, and graft function recovery after VA-ECMO use in primary graft dysfunction after heart transplantation.
Tufts Medical Center, Boston, MA

2014 to 2018, 160 Tx single center.

Nine (5.6%) PGD patients required VA-ECMO support

All successfully decannulated in a median of 10 days

Survival to discharge rate was 88.9%.

One-year survival rate was 85.7%.

Team work seems to be more important Than Ideal Device!!!