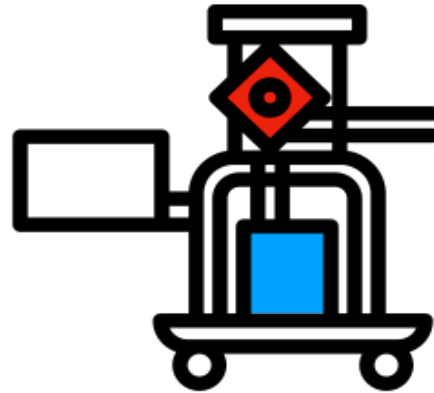




ECMO in the armamentarium of transplantation



Greg Calligaro
12th November 2022



GROOTE SCHUUR HOSPITAL
**HEART AND LUNG
TRANSPLANT UNIT**



**29th SATS & 6th SATiBA
CONGRESS**

11 – 13 November 2022

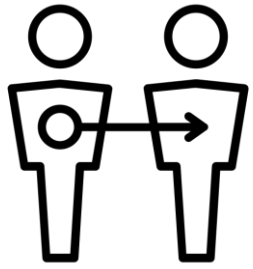
STIAS, STELLENBOSCH, CAPE TOWN

Disclosures

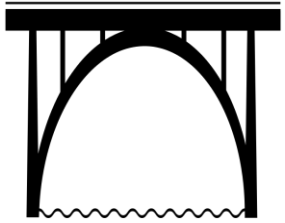
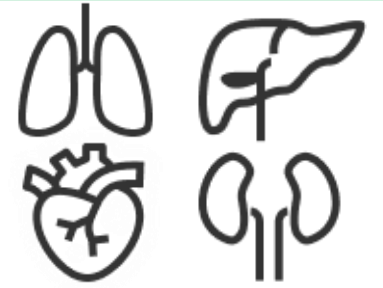
I have no disclosures relevant to this presentation.

I have received honoraria for academic talks from Novartis, GSK, AstraZeneca, Boehringer and Fisher-Paykel.

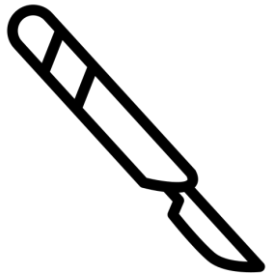
I have participated in advisory boards for Boehringer (interstitial lung disease) and AstraZeneca (asthma).



Organ-preserving ECMO (OP-ECMO)
(normothermic regional perfusion)



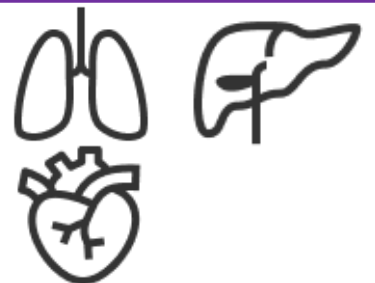
Bridge-to-transplant

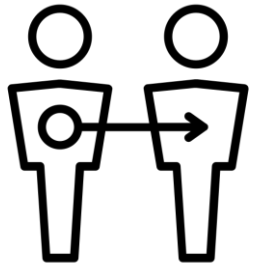


Intraoperative ECMO

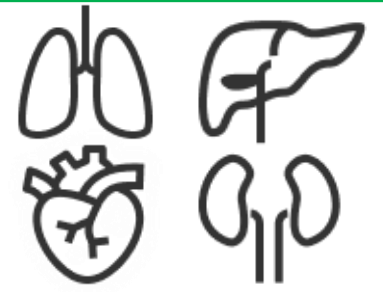


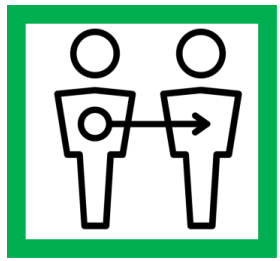
Primary graft dysfunction
Post-operative complications



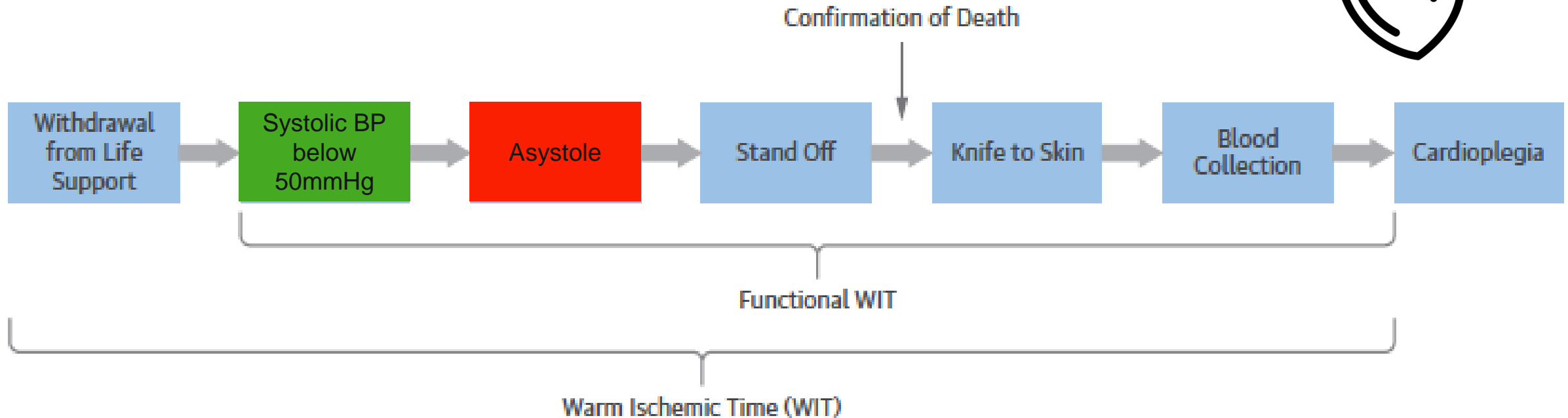
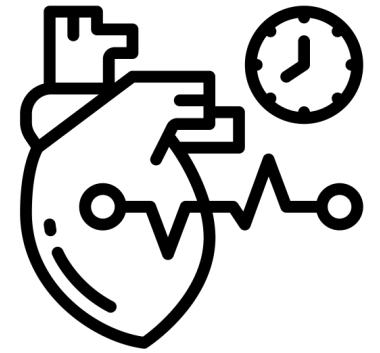


Organ-preserving ECMO (OP-ECMO)
(normothermic regional perfusion)



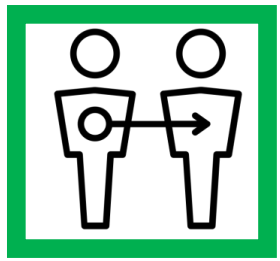


Organ-preserving ECMO (OP-ECMO): optimising outcomes from DCD donors

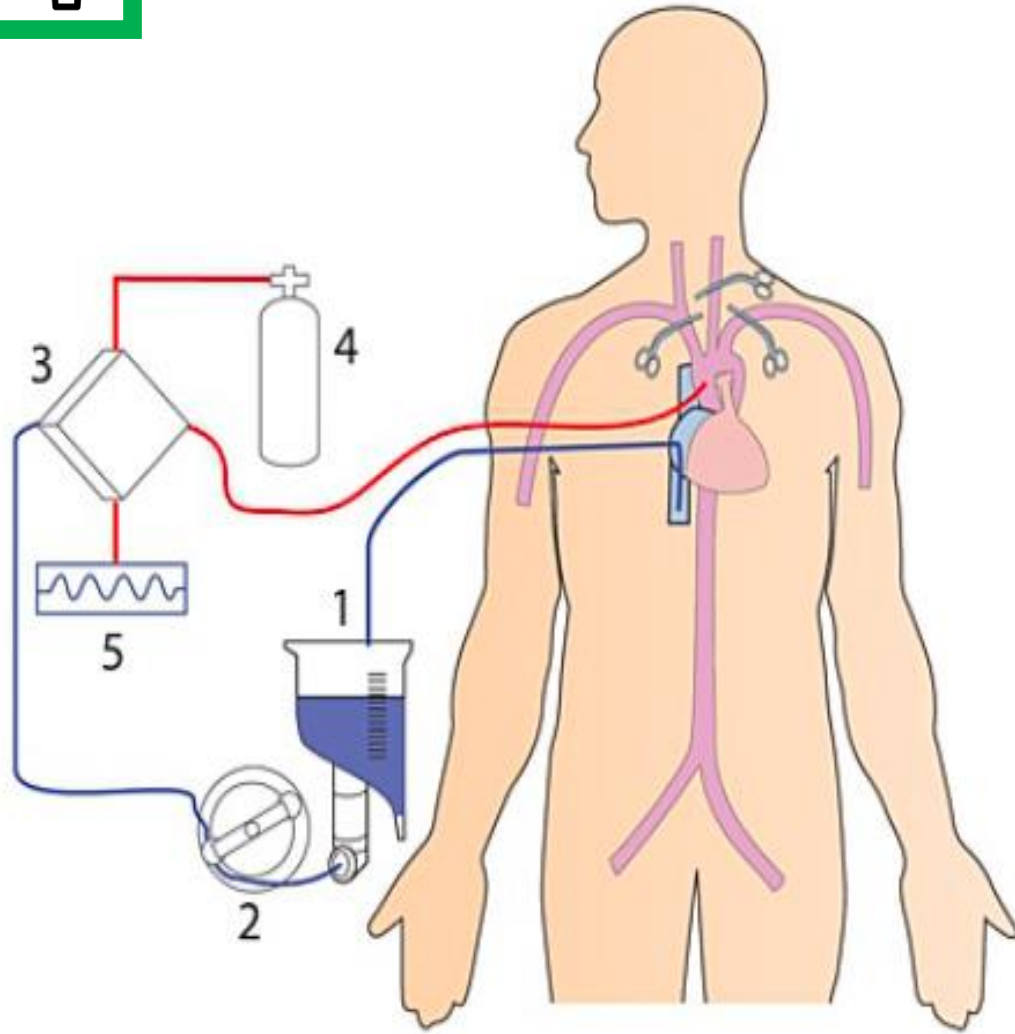


DCD increases pool of abdominal organs and lungs but its impact on heart donor pool is limited (due to ↑ sensitivity to warm ischaemia)

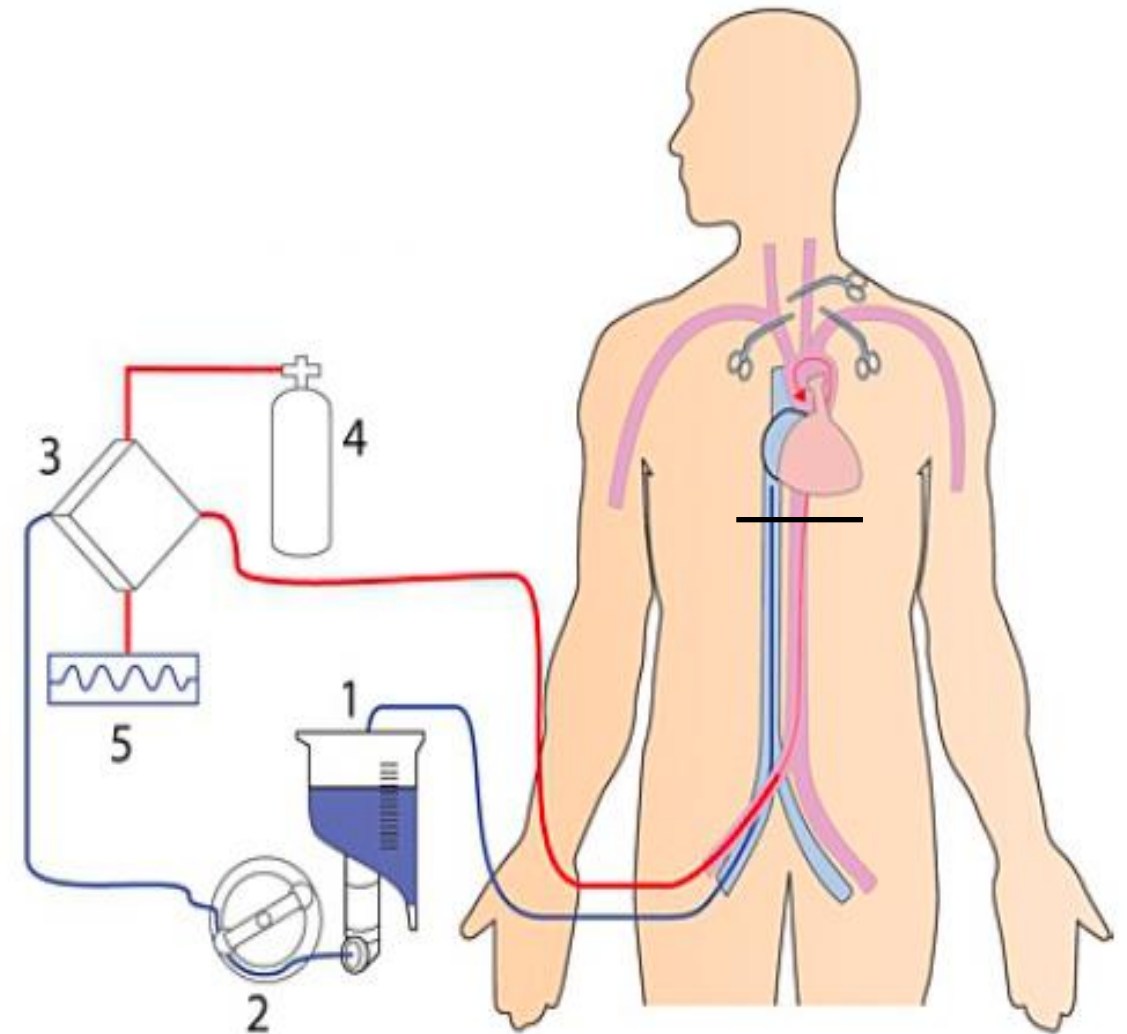
Rapid restoration of oxygenated blood flow with **normothermic regional perfusion (NRP)** can reverse warm ischaemia



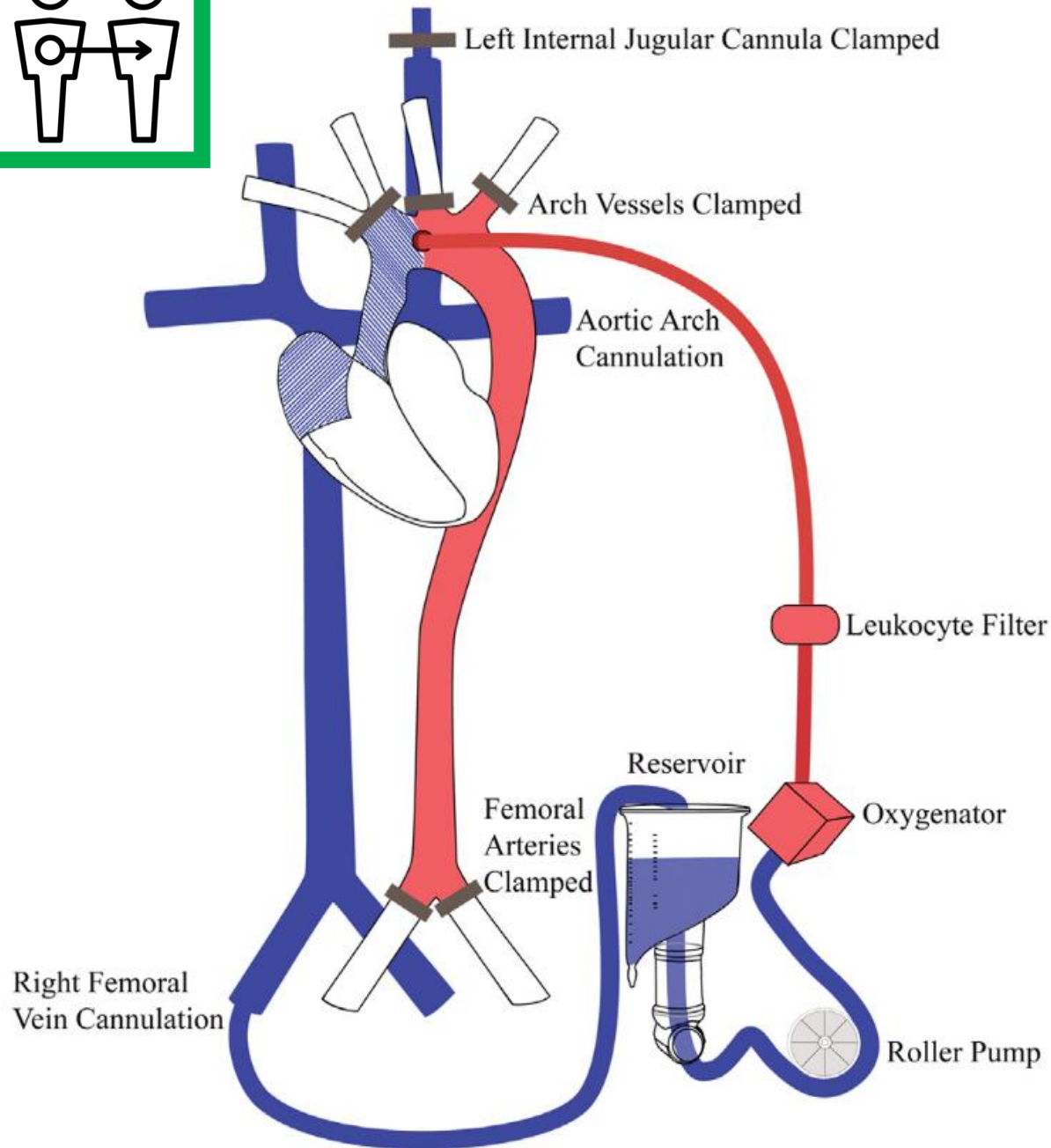
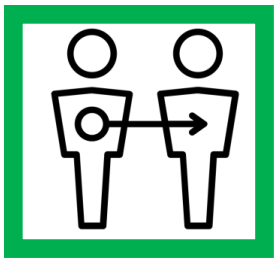
Using VA-ECMO for NRP



Thoraco-abdominal (TA-NRP)



Abdominal (A-RP)



Heart usually starts beating within 2-3 minutes after reperfusion – may initially need support with pressors/inotropes



Visual inspection of cardiac function and lactate measurement for 30-60 minutes, NRP weaned

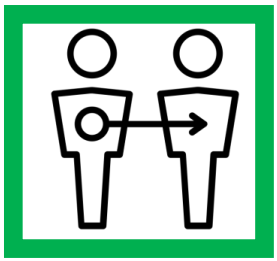


Decision to procure heart?



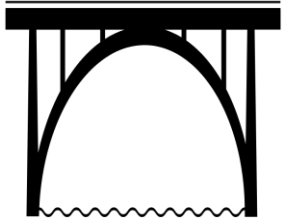
Reanimated heart can be retrieved conventionally and transported by static cold storage (SCS)

Figini MA *et. al.* Transplant Proc., 2020.
Tchano-Soto V *et. al.* J Heart Lung Transplant, 2019.
Chew HC *et. al.* JACC, 2019.



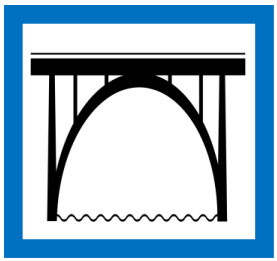
What does TA-NRP with ECMO add?

- DCD heart donors have the potential to increase the donor pool by 15-30% - but *ex-vivo* OCS is usually required
Dhital K *et. al.* Lancet, 2020.
- TA-NRP in DCD heart donors in conjunction with cold storage following retrieval can potentially abate the need for OCS – making this economically viable in LMICs
Messer S *et. al.* J Heart Lung Transplant, 2019.
Smith D *et. al.* J Thorac Cardiovasc Surg, 2021.
Hoffman JRH *et. al.* J Heart Lung Transplant, 2021.
- TA-NRP in DCD liver donors reduces the risk of ischaemic cholangiopathy
Watson CJ *et. al.* Am J Transplant, 2019.
- Multicentre retrospective study from Spain showed *in-situ* cold perfusion is associated increased odds of delayed graft function and 1-year graft loss compared to NRP
Padilla Maria *et. al.* Am J Transplant, 2021.



Bridge-to-transplant



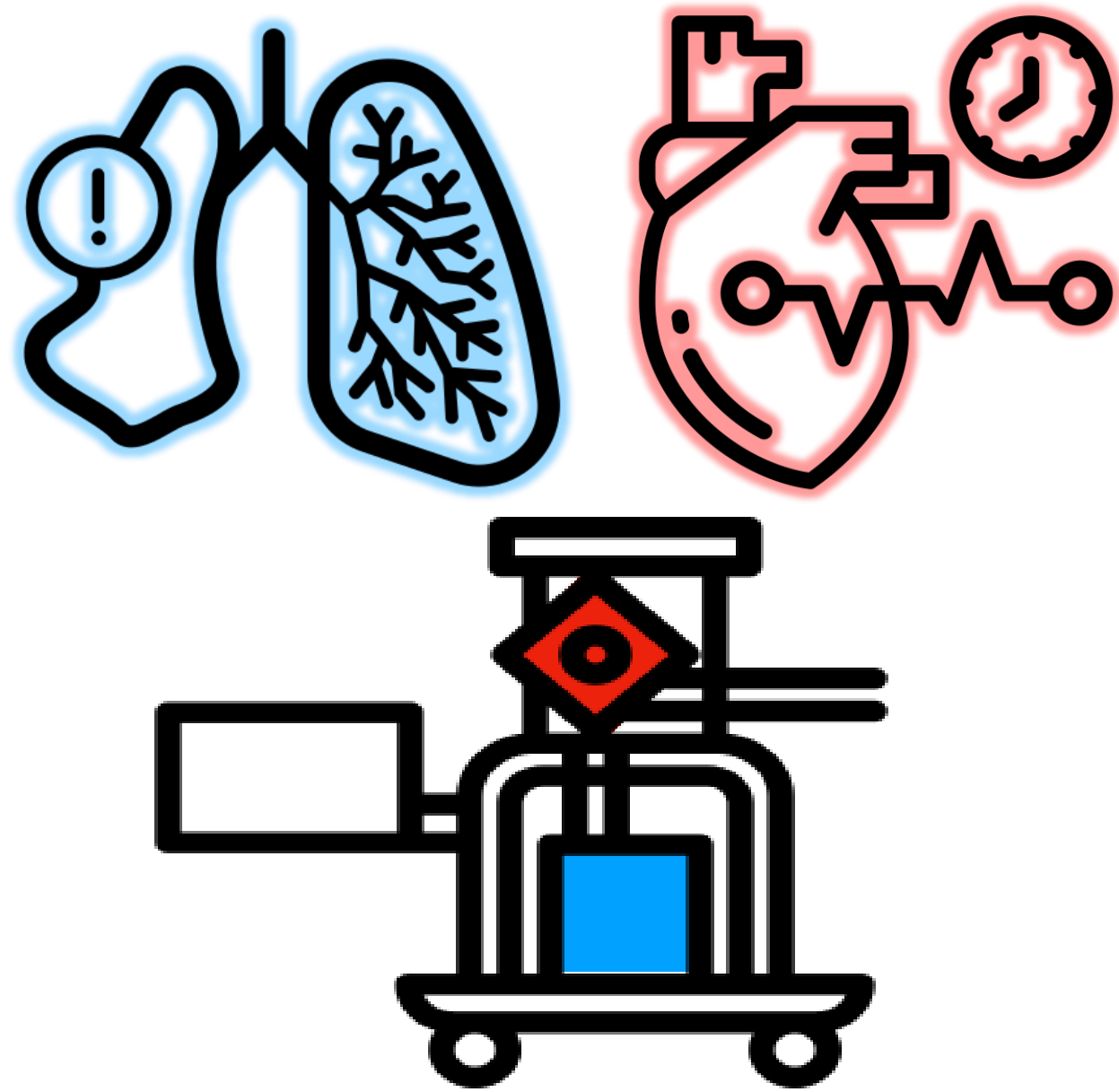


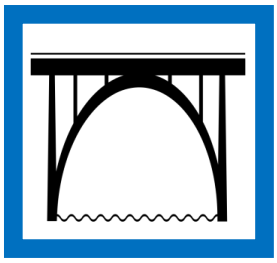
Thou shalt not use ECMO unless ...

The problem
is
reversible

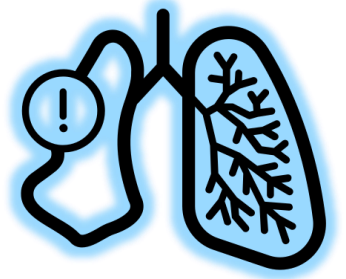
OR

There is a destination
therapy





Bridge-to-lung transplant

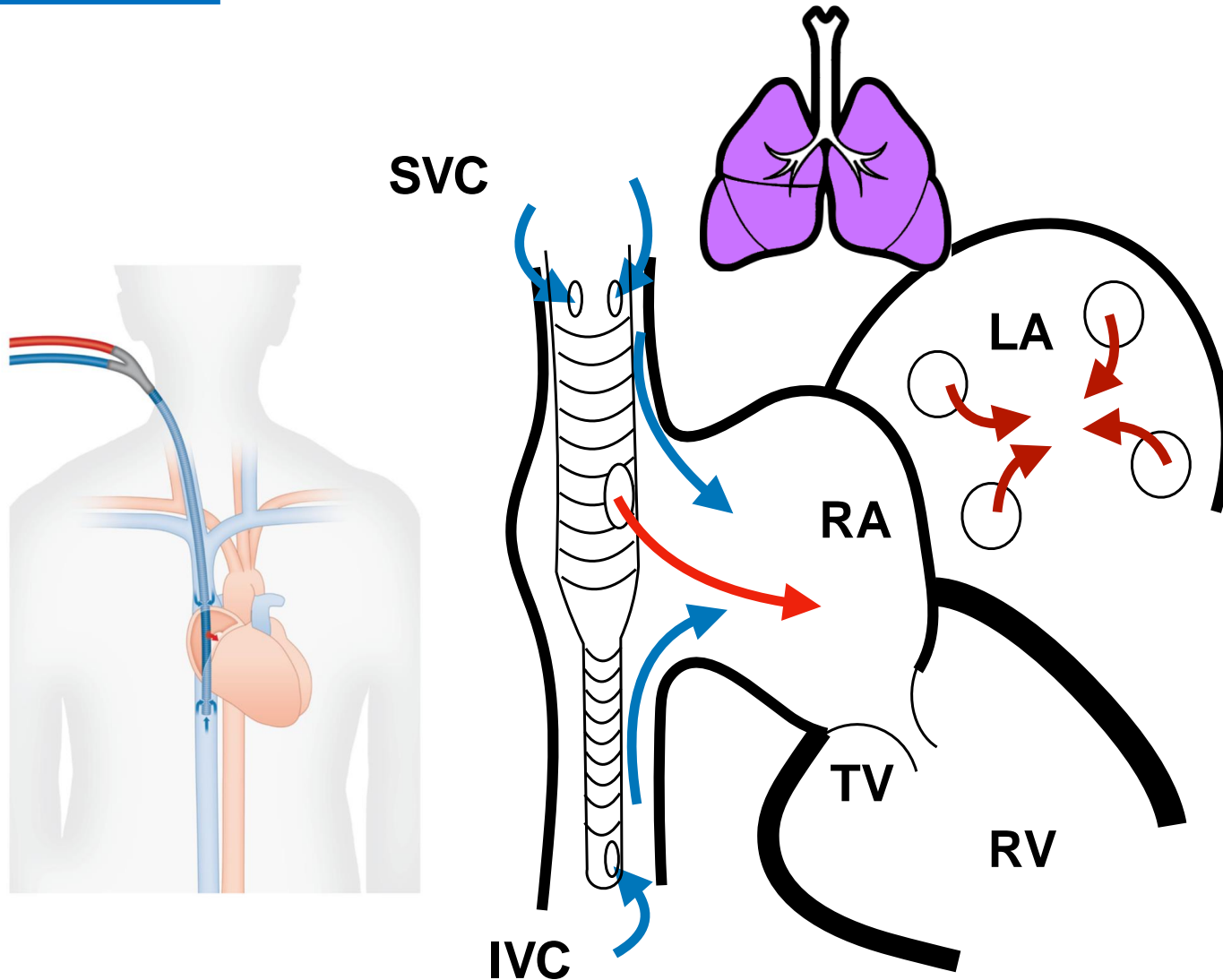


- The overall utilisation of ECMO as a bridge to transplant is miniscule compared to total number of LTXs
- United Organ Sharing Network (UNOS) database: 21,927 patients transplanted over last 5 years, only 414 bridged using ECMO
- 65 LTX centers in the US, only 26 bridged; 12/26 (almost half performed only 1 transplant per year from ECMO)
- Many early single-center studies showed worse outcomes for ECMO as BTT: 30-day, 1 year and 2-year survivals of 89%, 68% and 53% vs. 96%, 85% and 79% for controls
- The expertise for this kind of transplant is concentrated in a few specialised high-volume units (where outcomes may be similar)

www.UNOS.org
Hayes D et. al., AJRCCM, 2016.
Inci I et. al. Transplantation., 2015.
Hayanga AJ et. al. Resp. Care, 2016.



Cannulation strategy must support ambulation



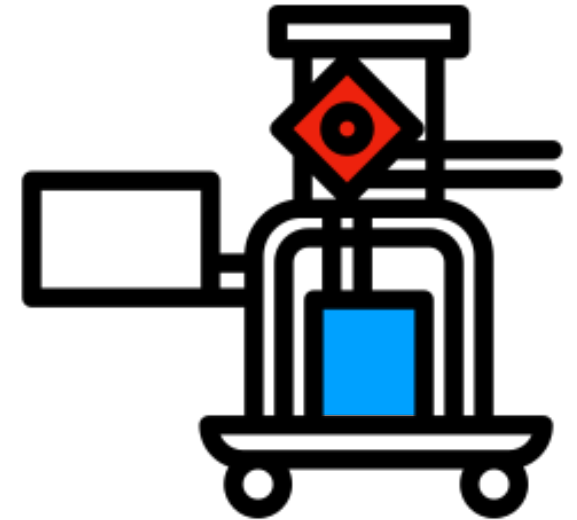
Cartoon courtesy of Tim Pennel.





Management of the patient on ECMO

- Almost always VV-ECMO mode
- Ventilator and sedation management (ideally, awake and tracheostomised)
- Restrictive transfusion strategy (minimise fluid overload and sensitisation)
- Effective anticoagulation, minimising risk of bleeding and close attention to circuit for clotting complications
- Intensive physical rehabilitation

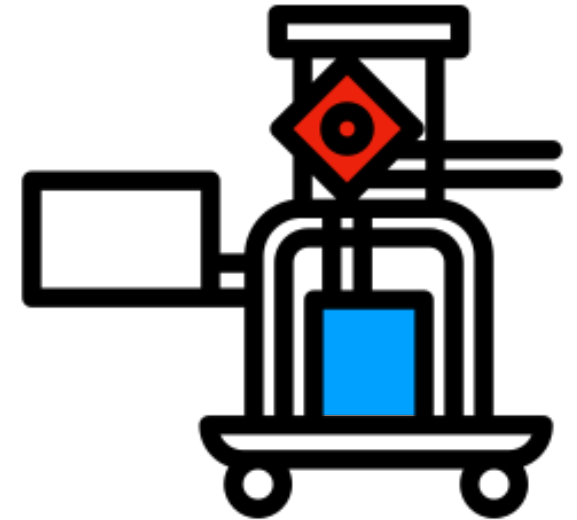


Javidfar J, *et. al.* J Thorac Cardiovasc Surg., 2012.
Rehder KJ, *et. al.* Resp. Care, 2013.
Sharma N, *et. al.* Annals of Trans. Med., 2017.

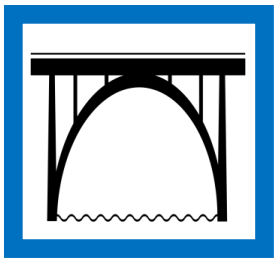


The window for transplantation is narrow...

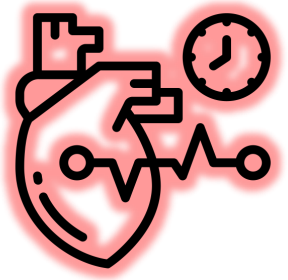
- Deteriorating nutritional status
- Development of neuromuscular weakness
- HLA allo-sensitisation due to multiple blood transfusions
- Bleeding (common – ~45% in some series)
- Thrombosis (\pm systemic embolisation)
- Worsening right heart dysfunction (if on VV-ECMO)
- Major depression and post-traumatic stress



George TJ, *et. al.* ISHLT, 2012.
Vaja R, *et. al.* J Crit Care, 2015.
Aubron C, *et. al.* Ann Intensive Care, 2016.



Bridge-to-heart transplant



- Must be VA configuration – more bleeding, lower limb ischaemia, intracranial haemorrhage

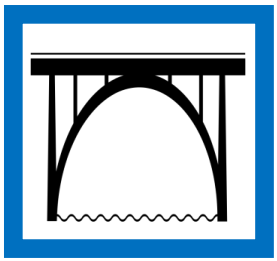
Cheng R *et. al.* Ann Thorac Surg, 2014.
LE Guennec L *et. al.* Ann Intensive Care, 2018.
Suarez L *et. al.* J Vasc Surg, 2017.

- Concomitant use of IABP or Impella may lead to improved outcomes

Barge-Cabellero G *et. al.* Interact Cardiovasc Thorac Surg, 2019.
Pappalardo F *et. al.* Eur J Heart Failure, 2017.

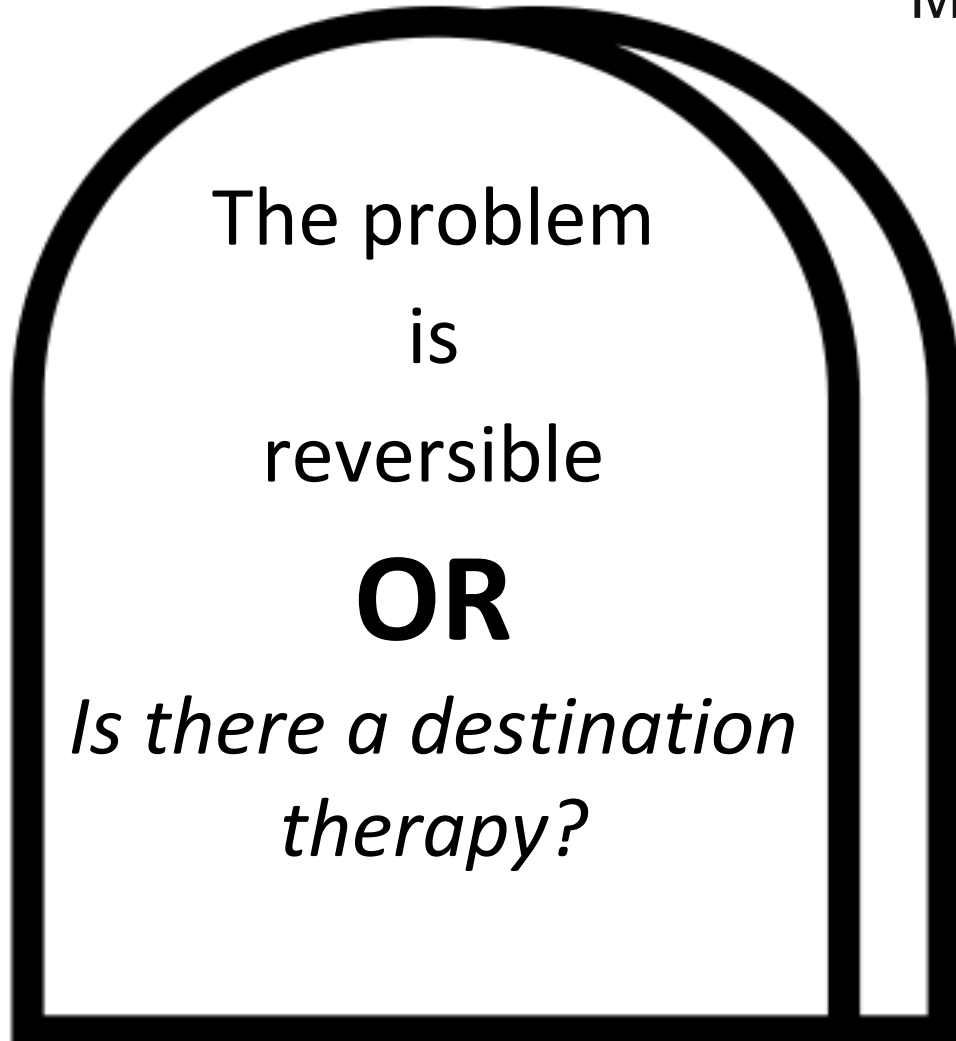
- Another destination therapy is possible with hearts – “bridge-to-bridge” or “double-bridged” to durable LVAD device but this is associated with two-fold increase in post-LVAD mortality,

Netuka I *et. al.* J Heart Lung Transplant, 2020.
Shah P *et. al.* Ann Thorac Surg, 2017.
Hernandez-Montfort J *et. al.* J Heart Lung Transplant, 2020



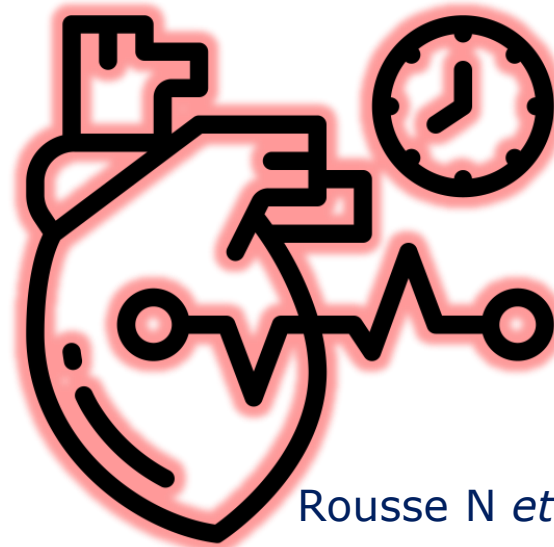
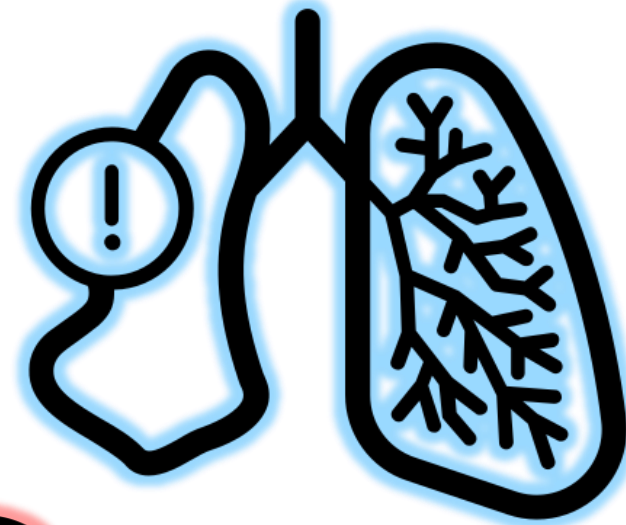
Thou shalt not use ECMO unless ...

Mean duration on ECMO before Tx:



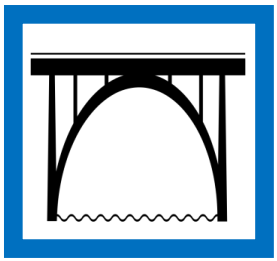
13-25 days

Hoopes CW *et. al.* J Thorac Cardiovasc Surg 2013.

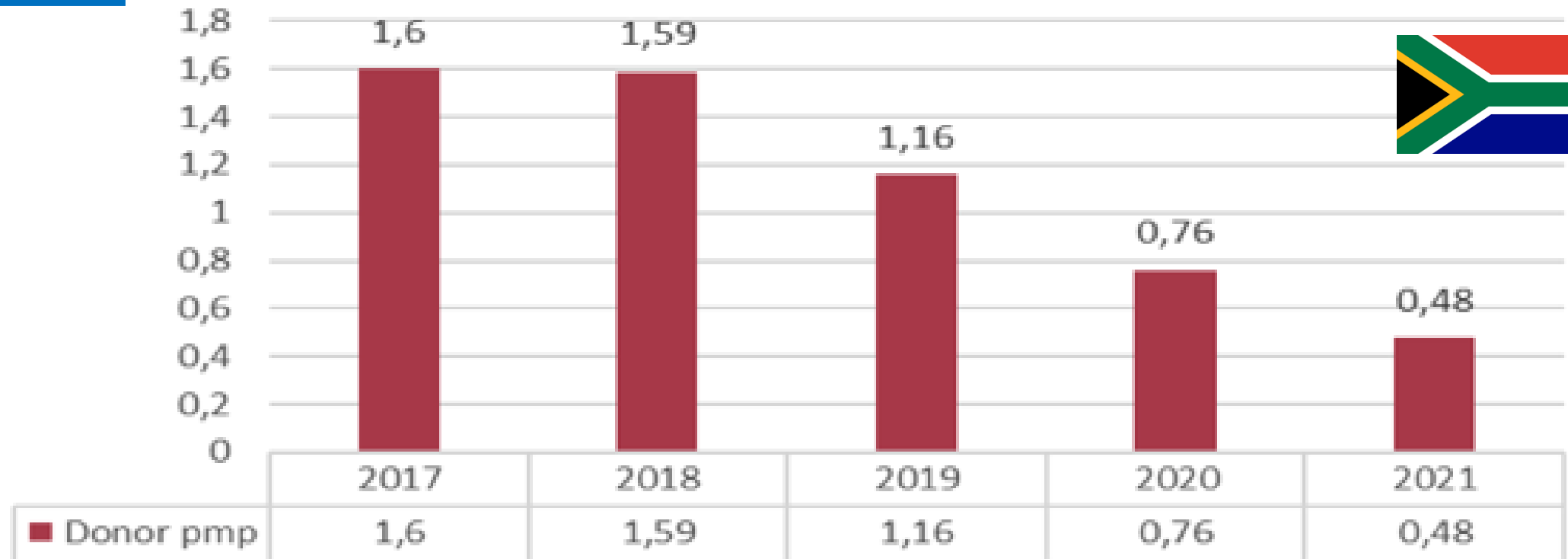


4.5 days

Rousse N *et. al.* Int J Cardiol, 2015.



SA deceased donation rate (per million population)



24.9



49.6



3.77



18.1



19.6



21.6



36.9



0.51

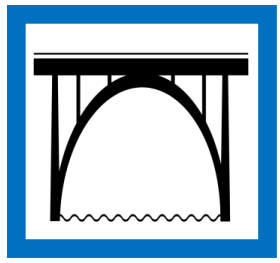


5.1



21.6

Reproduced with permission: "5-Year Report of National Organ Donation and Transplant Statistics: South African Transplantation Society" – Anja Meyer and Vuyiseka Soyizwapi; compiled May 2022 (*unpublished*)



Bridge-to-transplant prioritises **URGENCY** over **BENEFIT**



Priority 1

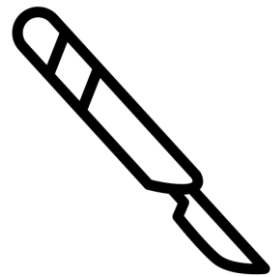
“Rule of rescue”

Top priority should be given to the patients with the least time to live



Priority 2

Priority given to best post-transplant outcome



Intraoperative ECMO





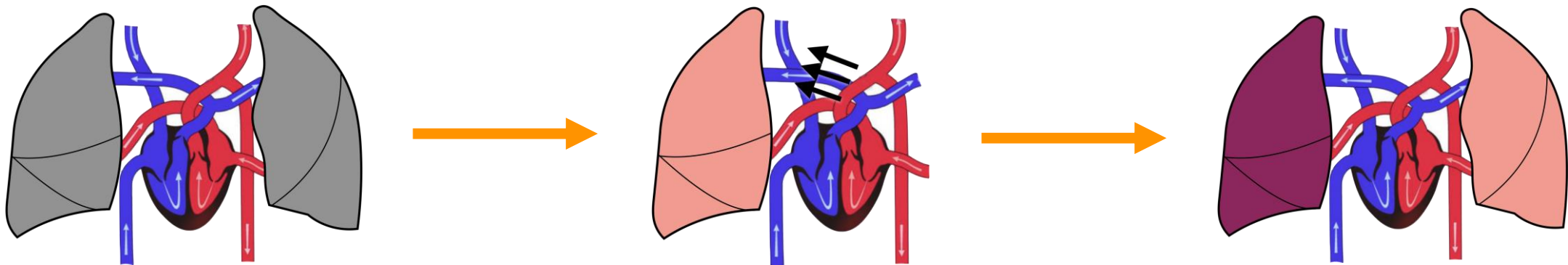
ECMO for intraoperative support during LTX

- Either cardiopulmonary bypass (CPB) or ECMO commonly used for mechanical support intraoperatively
- Conflicting data on whether no support (single lung ventilation) is better than ECMO (large study from Vienna reported lower PGD with ECMO)

Ius F et. al. J Heart Lung Transplant, 2016.

- Prophylactic intra-operative ECMO is employed in certain situations where haemodynamic instability is anticipated (either PAH or secondary PH) or in “first lung syndrome”

Cosgun T et. al. Int J Artif Organs, 2017.

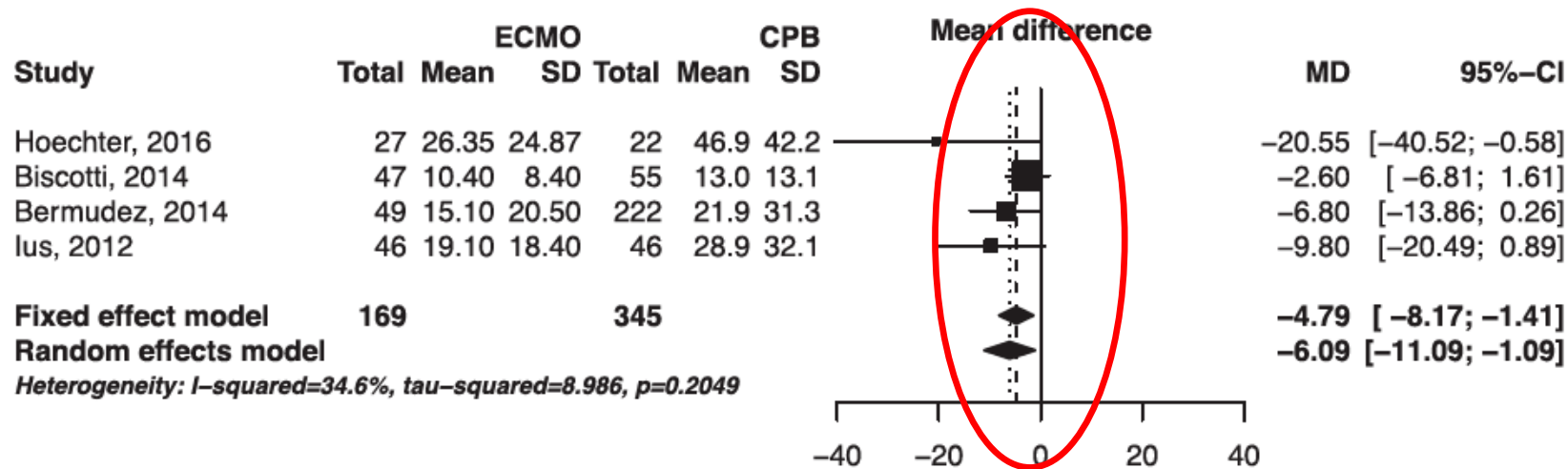


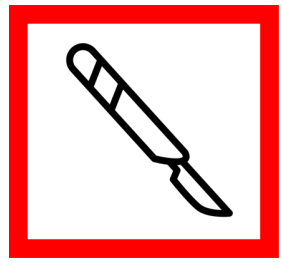


ECMO for intraoperative support during LTX

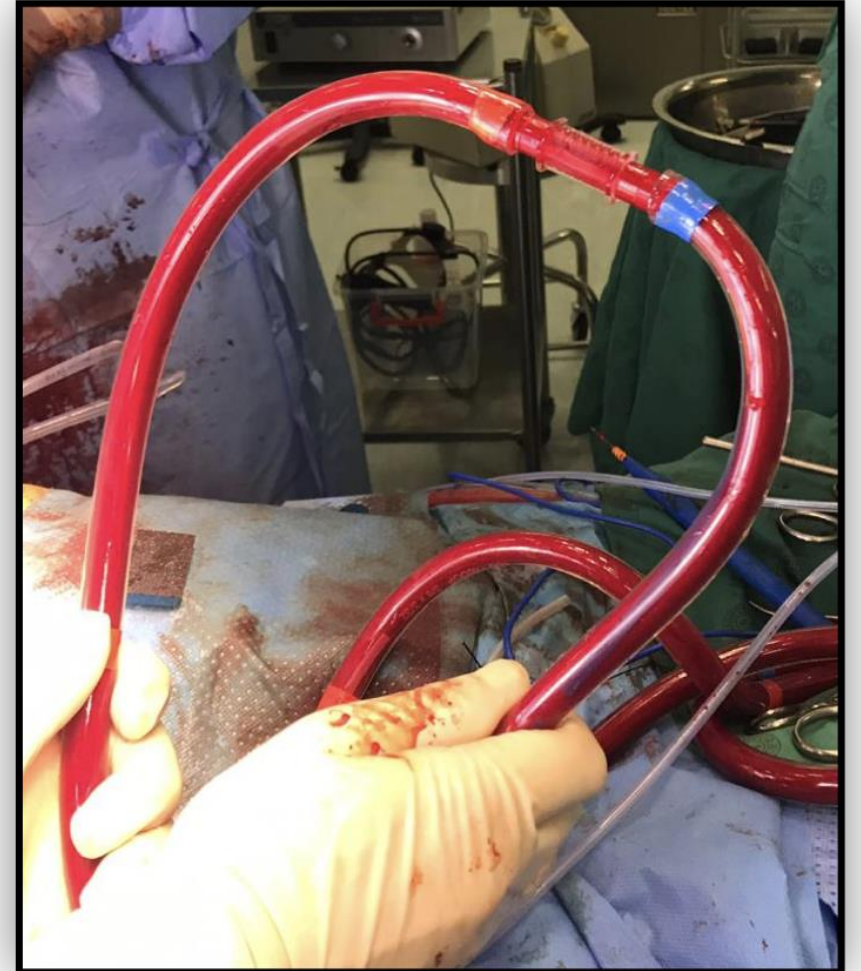
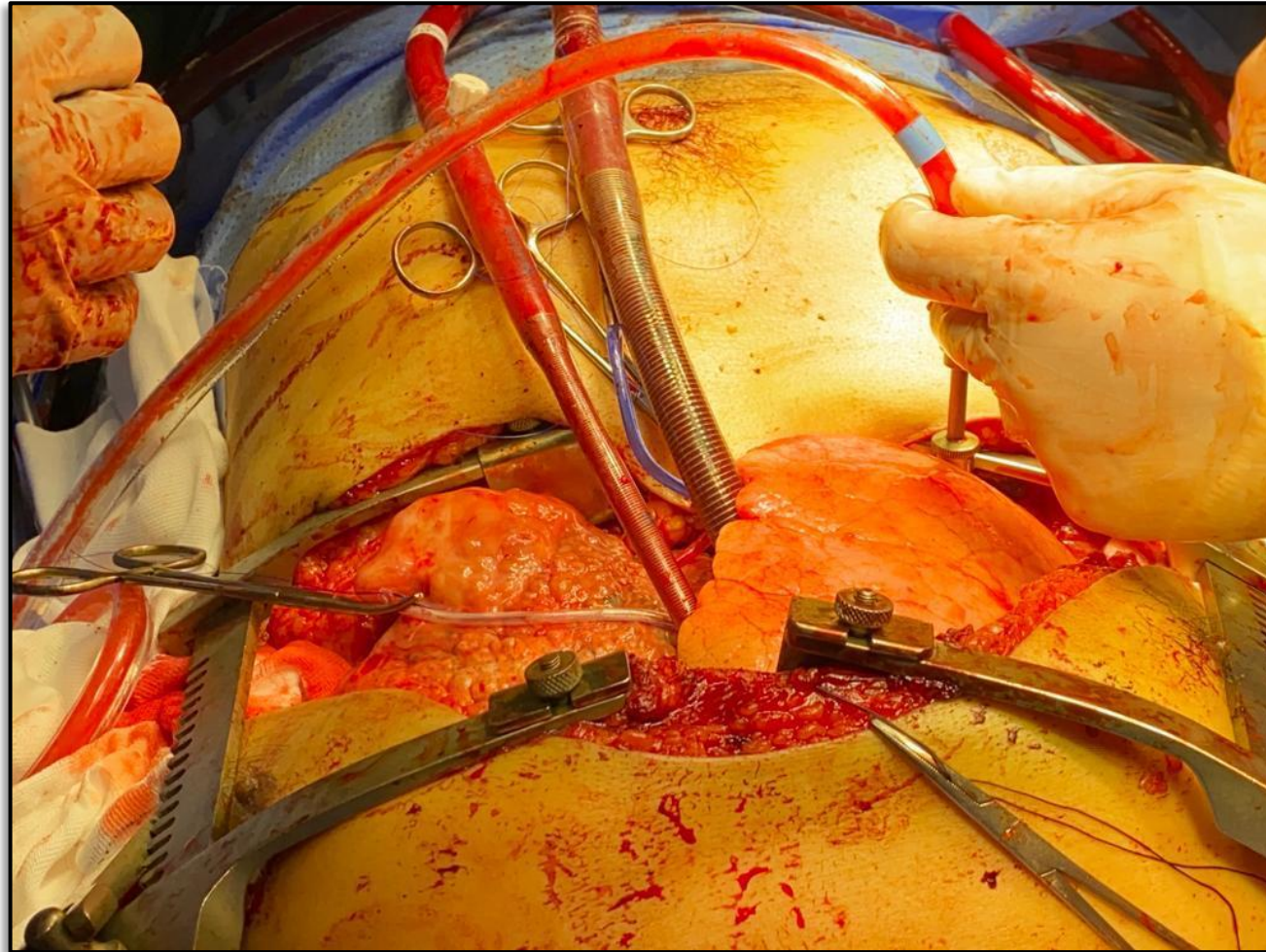
- ECMO has theoretical advantages over CPB (less heparinisation) but meta-analysis showed non-significant trend towards lower use of blood products
- Duration of mechanical ventilation and survival also comparable between the two groups - only ICU length of stay was significantly shorter

Hoechter J *et. al.* ASAIO J, 2017.



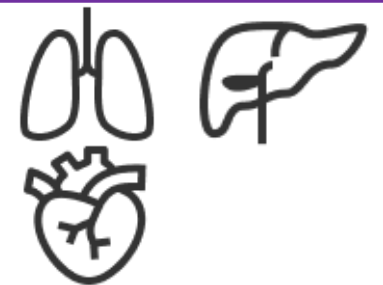


Bilateral sequential LTX technique at GSH



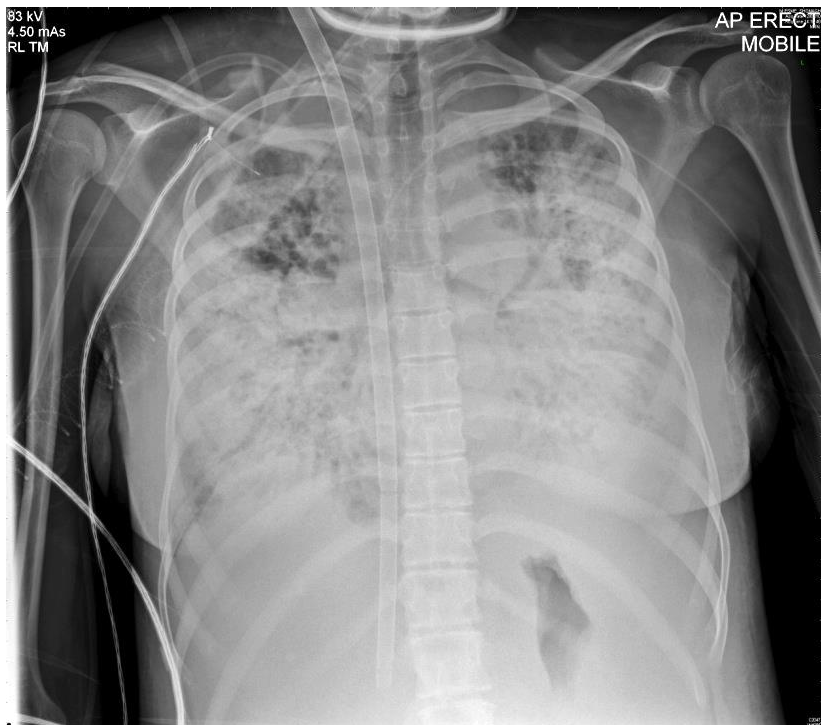
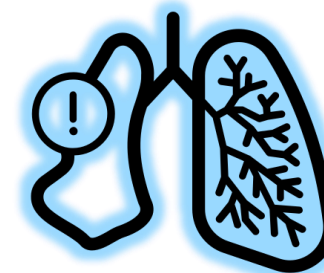
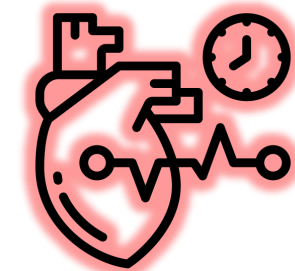


Primary graft dysfunction
Post-operative complications





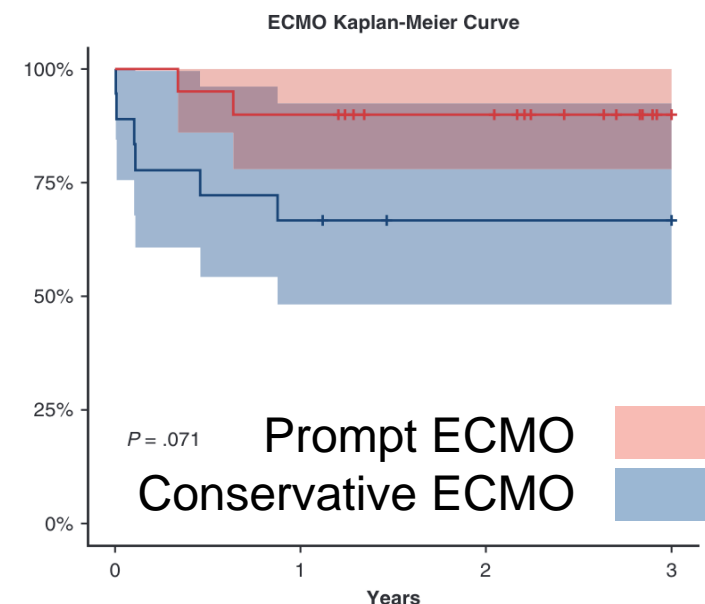
ECMO for primary graft dysfunction



Use of post-transplant for PGD 3 (P:F<100)
VV-ECMO in ~5% of LTX cases
Associated with reduced (~60%) 1-year
survival

Harano T *et. al.* ASAIO J, 2022.
Bermudez C *et. al.* Ann Thorac Surg, 2009.

Salvage therapy in failure
to wean of bypass in HTX
(~10%)



De Roo S *et. al.* J Thorac
Cardiovasc Surg, 2019.

POD 1



POD 2



POD 6



POD 18



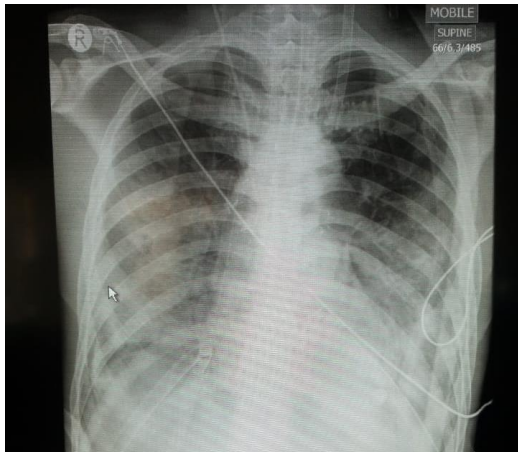
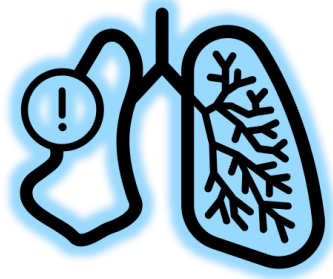
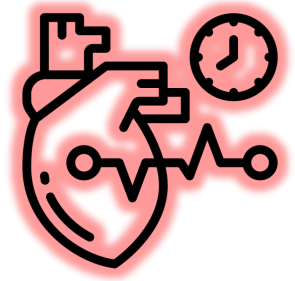
POD 30





ECMO for other causes of cardiorespiratory failure

- Post-operative ARDS, airway problems, pulmonary infection, fluid overload
- In liver transplantation, ECMO has been used to treat acute pulmonary and cardiac dysfunction following OLT (including hepatopulmonary syndrome)
- 6-month survival of immunosuppressed patients treated with ECMO is ~30%



30M (Cystic fibrosis)
POD 14
Pseudomonas VAP
Fluid overload
PGD
VV-ECMO x 15 days

Braun J *et. al.* Transplantation, 2019;
Schmidt M *et. al.* Am J Respir Crit Care Med, 2018.

Summary

- ECMO may be a feasible way of increasing cardiac donor pool without OCS
- Feasibility of ECMO as BTT depends on the donor organ availability within a programme, and careful patient selection
- Outcomes are generally worse than normal LTX although that might not apply to a few experienced, high-volume centers
- Not practically an option in SA currently?
- VA-ECMO is used for intraoperative support
- Essential tool for managing PGD and early cardiorespiratory complications (but the need for ECMO confers worse outcome)

Acknowledgements



- **Cardiothoracic surgeons:** Tim Pennel, Chima Ofoegbu, Natercia da Silva, Johan Brink
- **Transplant coordinators:** Babalwa Gili, Fiona McCurdie, Luke Steenkamp, Alexia Michaelides, Grant-Lee Hoffman, Vuyi Soyizwapi
- **Pulmonologists:** Keertan Dheda, Greg Symons
- **Intensivists:** Ivan Joubert, Dave Thomson, Malcolm Miller, Jenna Piercy
- **Anaesthetists:** Malcolm Miller, Justiaan Swanevelder, Adriaan Myburgh, Adri Vorster
- **Heart and Lung Transplant Clinic:** Karen Seele, Ashleigh Ryan, Mulalo Mofamadi
- **ICU staff:** D22 ICU nurses, technologists
- **Physiotherapists:** Marchelle Lake, Jacques Erasmus, Sameega Salie, Carolyn Davids



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TRANSPLANT UNIT**