ECMO in Lung Transplantation

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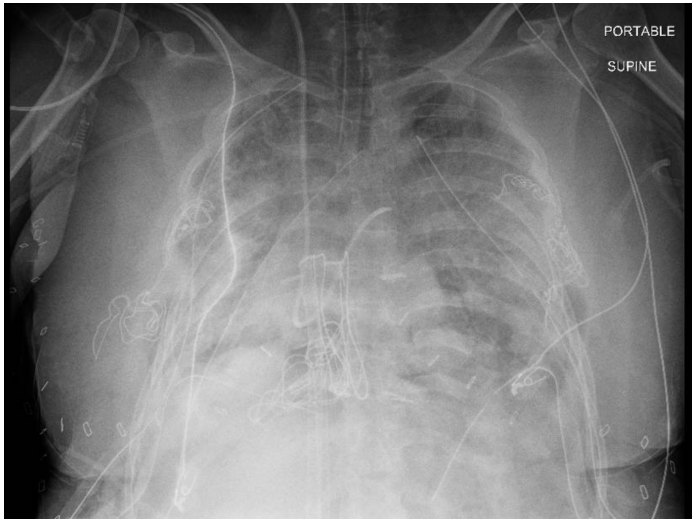
Financial Disclosures

- None

What can be so bad around a lung transplant that ECMO could be needed?

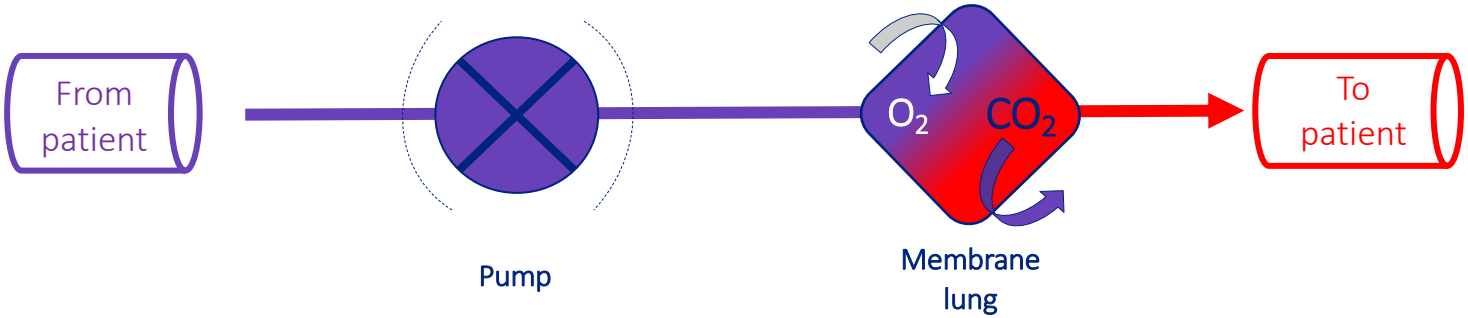




Presentation outline

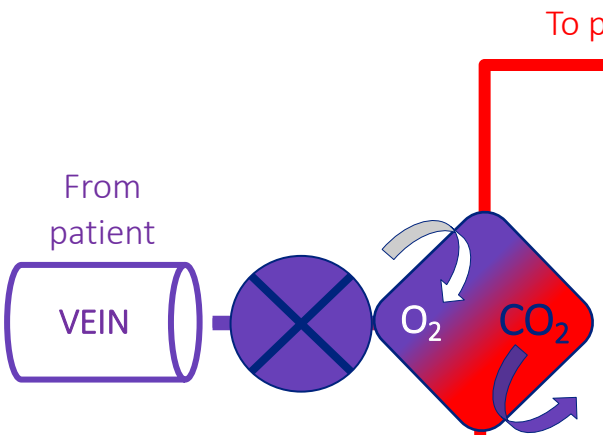
- ECMO, cannulation strategies and relevance in the lung transplant practice
- Technical aspects
- Preoperative ECMO: ECMO as Bridge to Transplantation
- Intraoperative ECMO
- Postoperative ECMO

What is an ECMO / ECLS?



Adapted from Lindstrom et al, MJA 2009 and Biscotti *et al*. ASAIO J. 2014.

Cannulation strategy dictates the support delivered



"VENO-VENOUS" ECMO
Pure respiratory support

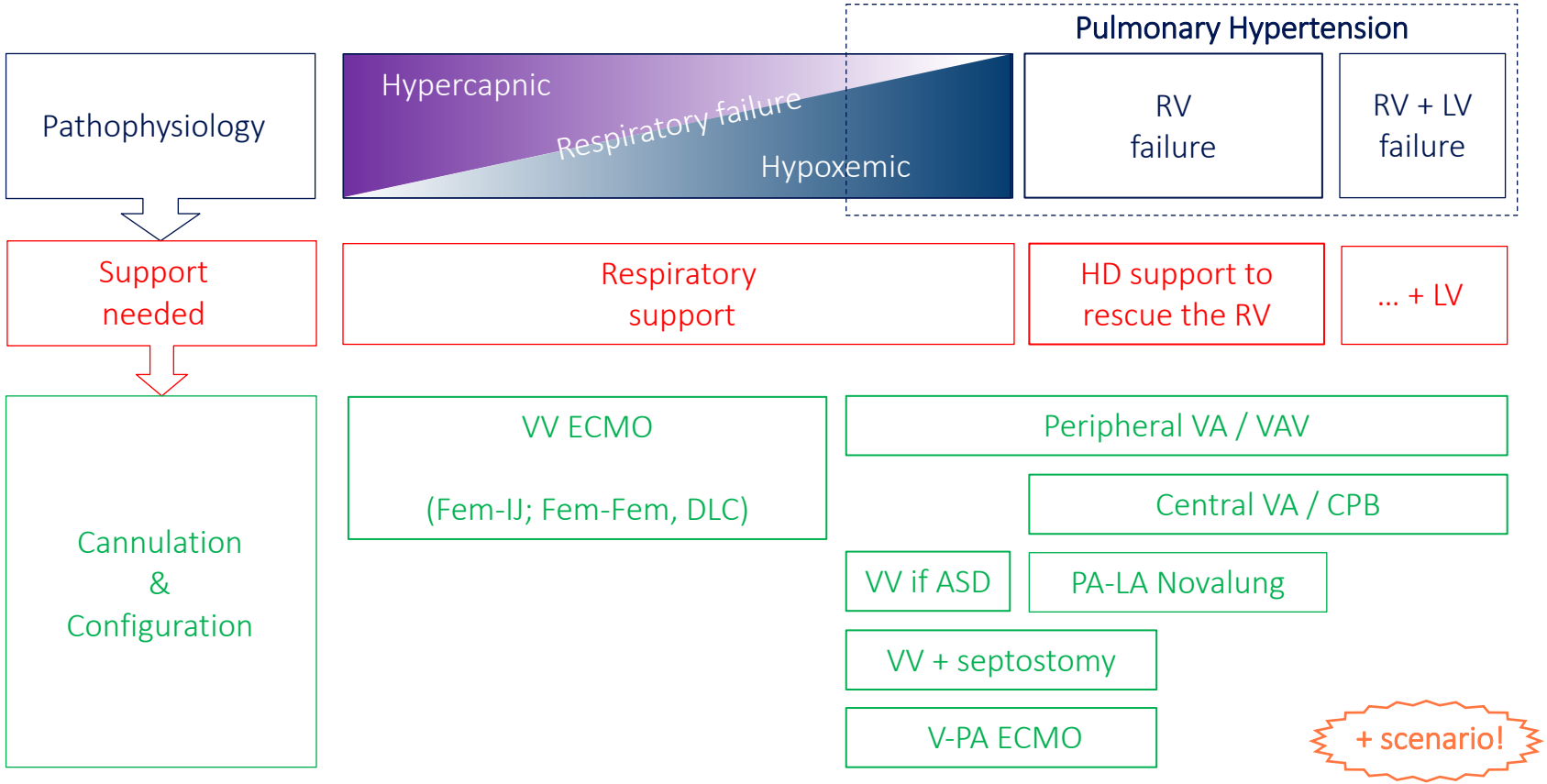
1. Peripheral
   - Double / single
   - Upper / lower
2. Central

- VV
  - Fem - IJ
  - Fem - Fem
- pVA
- pVAV
- DLC
- cVA
- PA-LA
- V-PA

"VENO-ARTERIAL" ECMO
Pure hemodynamic support

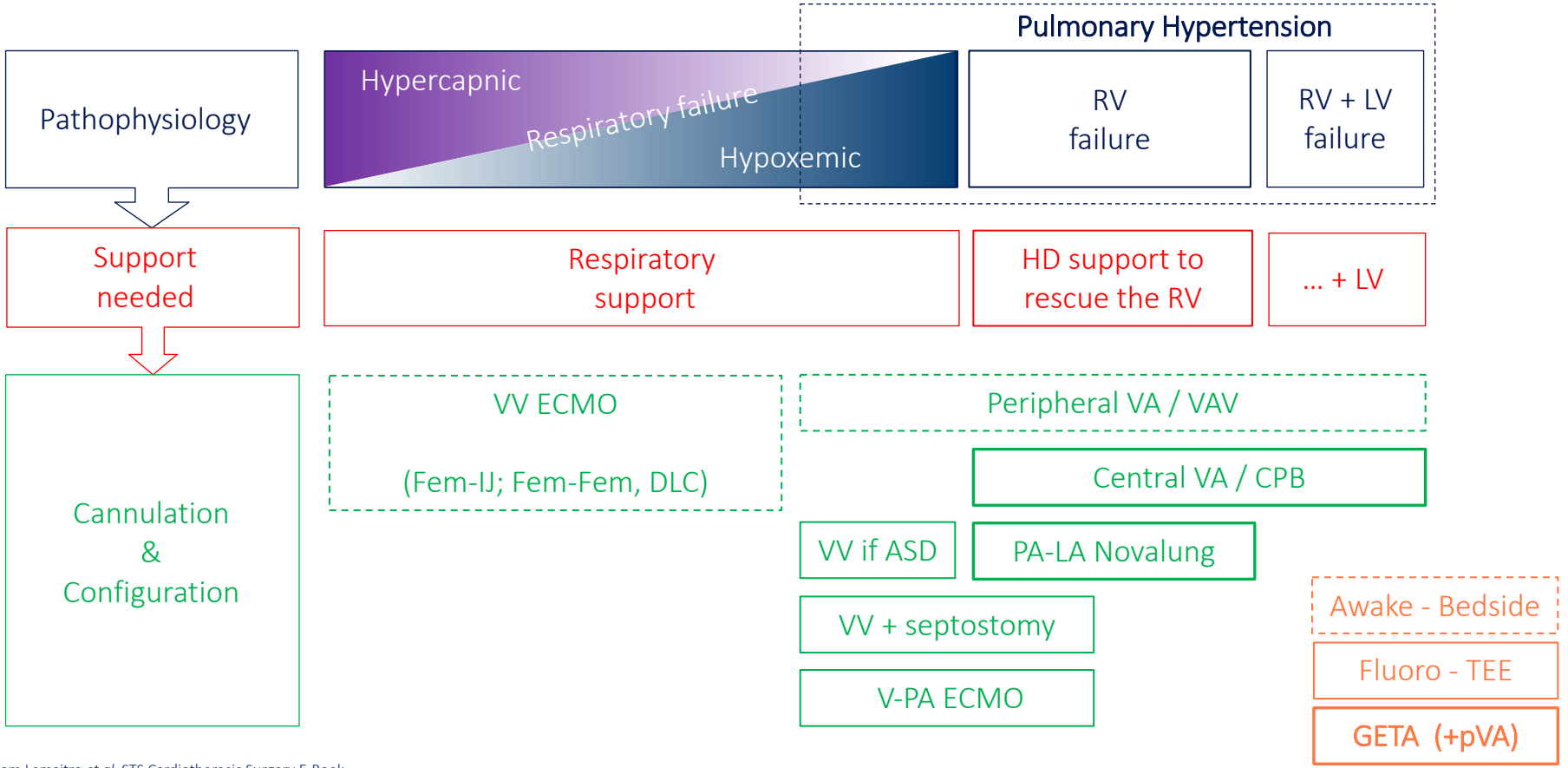
Adapted from Lindstrom et al, MJA 2009 and Biscotti *et al*. ASAIO J. 2014.

Patient's pathophysiology > support needed



Adapted from Lemaitre *et al.* STS Cardiothoracic Surgery E-Book

Patient's pathophysiology > support needed



Adapted from Lemaitre *et al.* STS Cardiothoracic Surgery E-Book

Integration in the broader picture

Patient's pathophysiology > support needed > cannulation strategy

1. Bridge to Transplantation: medical optimization fails
   - Isolated respiratory failure
   - **Isolated RV failure in decompensated pulmonary hypertension**
   - Combination
2. Immediate preinduction or intraoperative support
   - **Provide hemodynamic stability upon induction**
   - Ventilatory / **hemodynamic** support during the operation
3. Postoperative support
   - **Allow early control of R / L heart remodelling in PAH patients**
   - Primary graft dysfunction

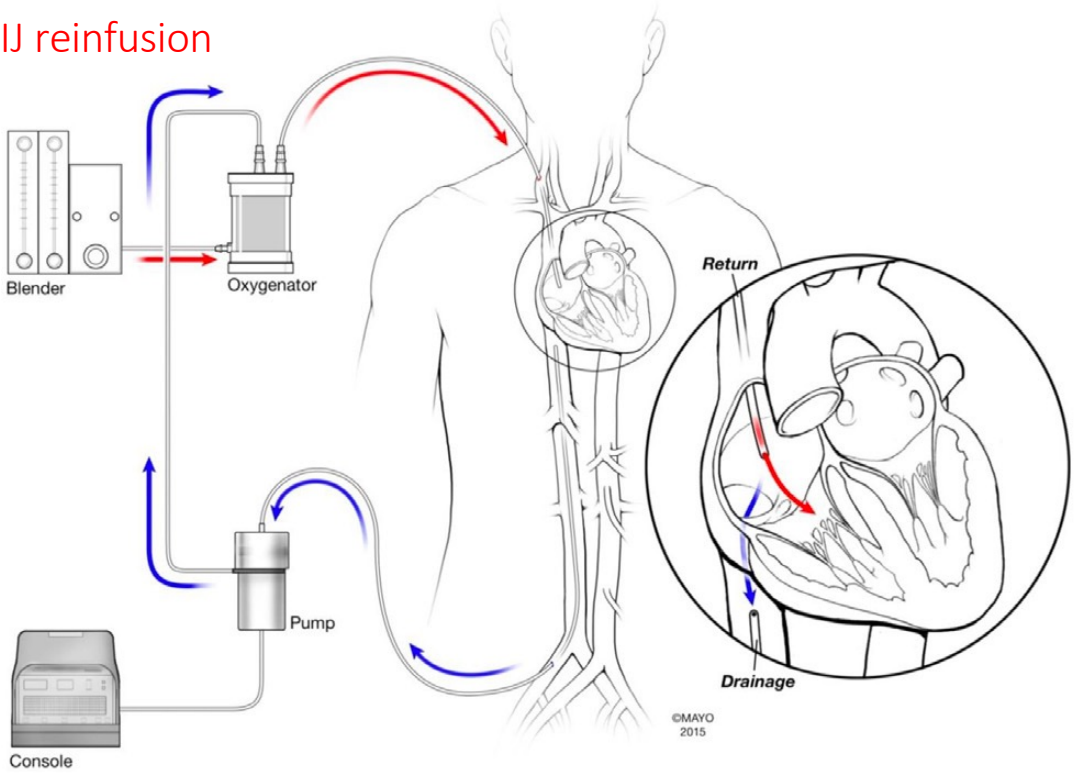
Integration in the broader picture

Patient's pathophysiology > support needed > cannulation strategy, **but not only!**

- **Sicker candidates**
  - ➢ PMH, PSH to be factored in
- **Older recipients**
  - ➢ Comorbidities, esp vascular
- **Higher BMIs**
  - ➢ ? Vent settings
- **Implant approach**
  - – Minimal invasive

VV ECMO

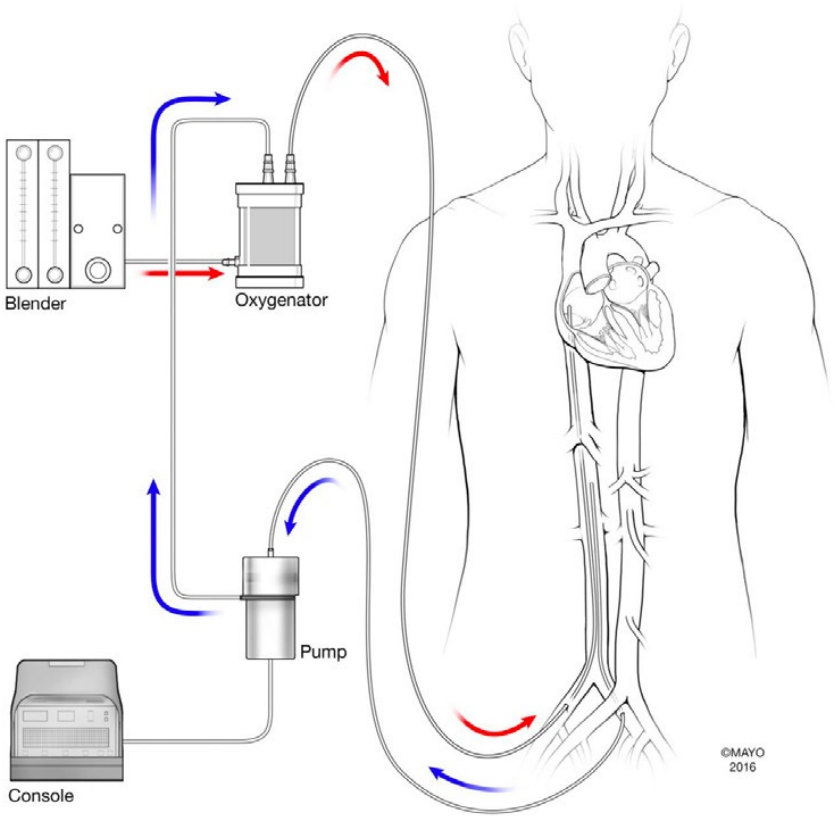
- **Fem-IJ cannulation**
  - FV drainage > IJ reinfusion



Adapted from Martin *et al.* JTCVA 2021.

VV ECMO

- **Fem-Fem cannulation**
  - FV drainage >
  - contralat FV reinfusion



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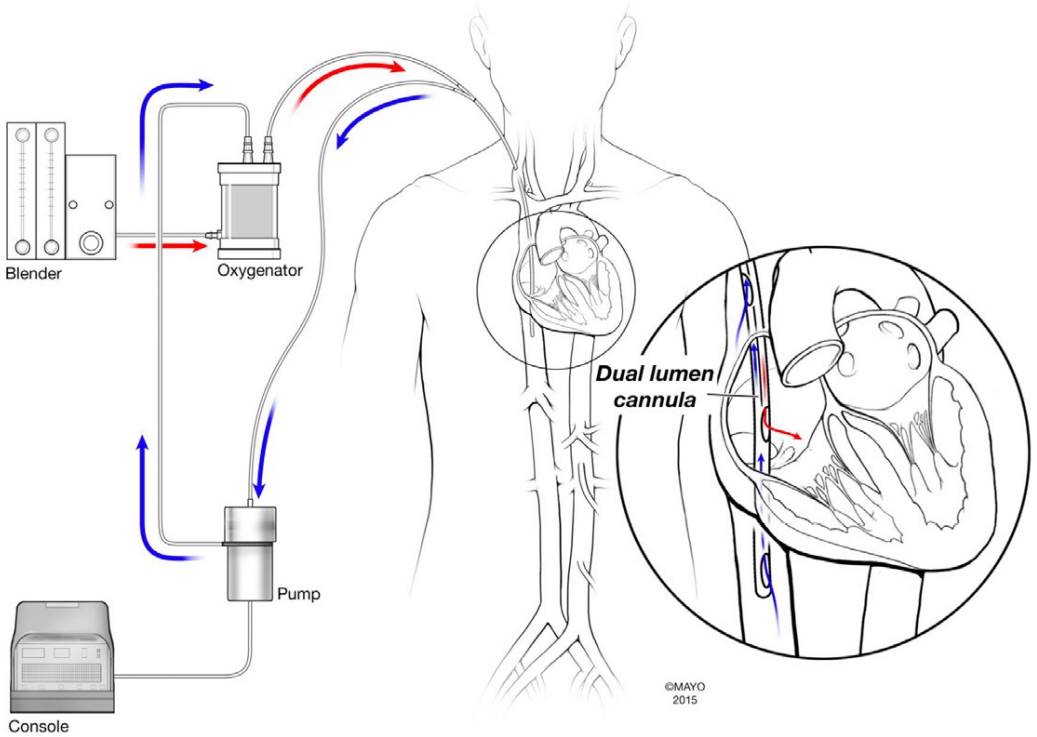
Adapted from Martin *et al.* JTCVA 2021.

VV ECMO

- Right Jugular single site, dual lumen cannula
  - Avalon®
  - Crescent®



Adapted from Martin *et al.* JTCVA 2021.

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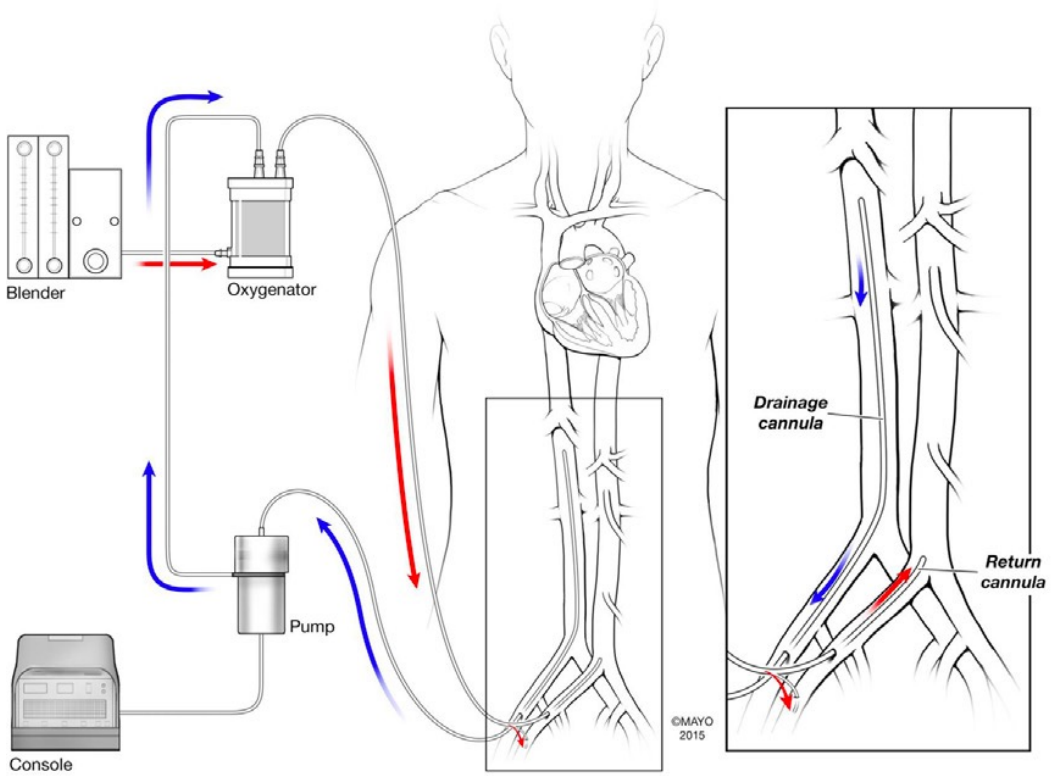
Peripheral lower body VA ECMO

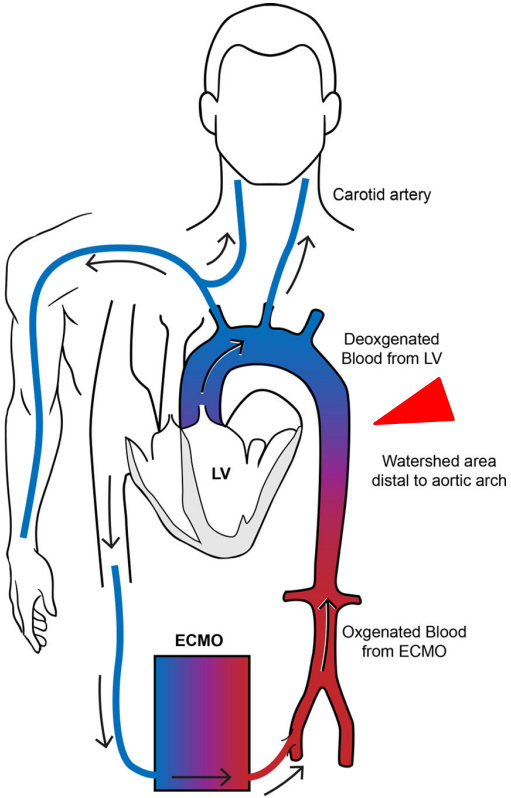
- **Fem-Fem cannulation**
  - FV drainage > CFA reinfusion
    - ± DPC for distal leg perfusion

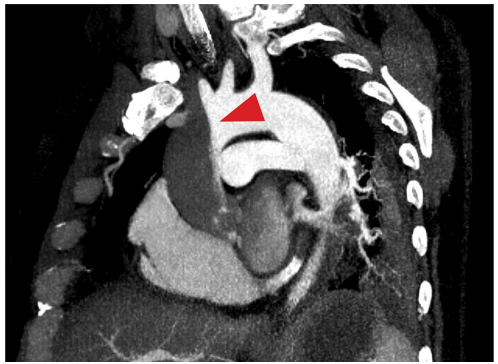


Adapted from Martin *et al.* JTCVA 2021.

Peripheral lower body VA ECMO

- **Fem-Fem cannulation**
  - Retrograde flow
    - > potential dual circulation
    - if lungs impaired
  - Need R arm monitoring
    - radial art line
    - Sat probe





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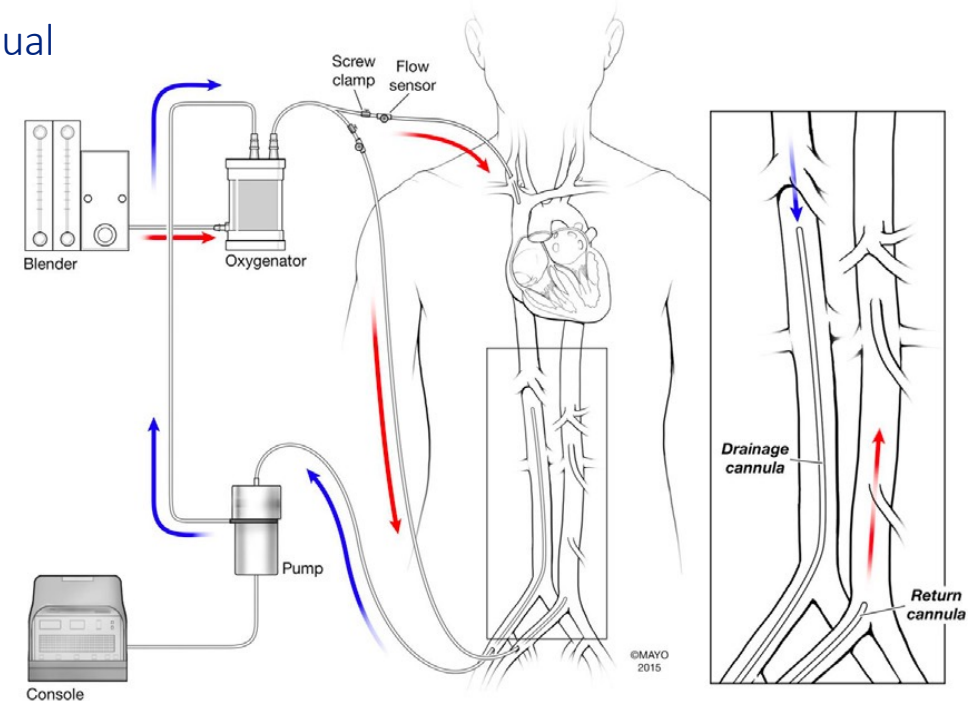
Adapted from Napp *et al.* CRC 2016.

Peripheral VAV ECMO

- **Addition of IJ reinfusion cannula to VA**
  - Provides well oxygenated blood to the residual native cardiac output
    - Eliminates upper body dual circulation with low PaO2



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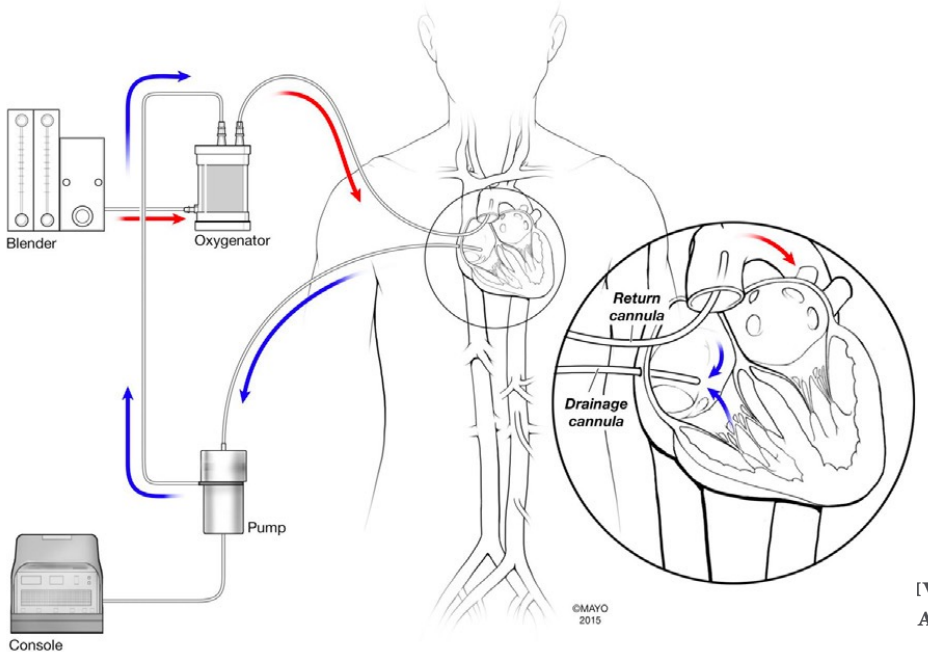
Adapted from Martin *et al.* JTCVA 2021.

Central VA ECMO

- RA > Ao cannulation
  - Full GA usually with pre-emptive pVA stabilization
  - Full or partial sternotomy, clamshell, mini thoracotomy
  - Antegrade flow



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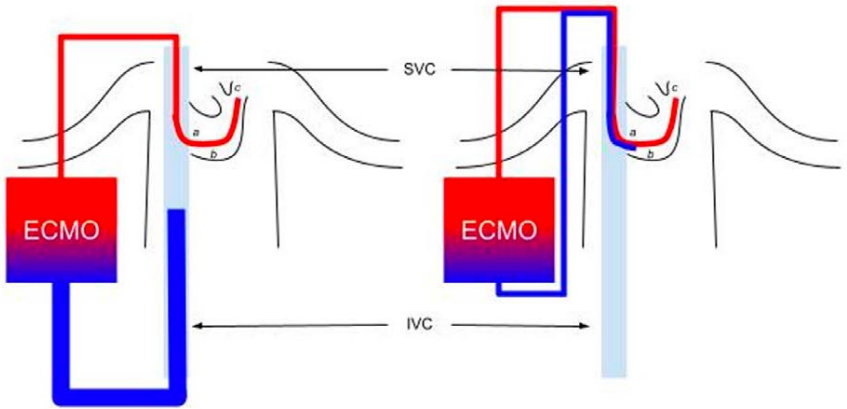
VenoPulmonary Arterial ECMO (V-PA)

- **Venous drainage to PA cannulation**
  - Mitigates RV dysfunction and poor gas exchange
  - Two cannulas: RA/IVC drainage > main PA reinfusion
  - DLC: RV drainage > main PA reinfusion
    - Protek Duo®
    - Spectrum DLC®
  - Cannulation under fluoro with TEE
  - Limited data available so far
  - Requires pullback if used as BTT > intraop



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Adapted from Hockstein *et al.* CCM 2024.

BTT: principles

- Inclusion
  - Listed patients: ECLS BTT should be discussed upfront
  - Bridge to decision only in highly selected patients

- Exclusion (relative?)
  - > 65 years old
  - Severe deconditioning
  - BMI > 30
  - Significant comorbidities
  - Prolonged MV
  - Uncontrolled sepsis or MOF

Except for isolated kidney or liver dysfunction in the context of PH

BTT: course

1. Extubate and mobilize: patients are awake!
2. Early transplant

3. Daily assessment
   - Support adequacy and need for reconfiguration
   - Transplant candidacy in the face of complications

4. Complications
   - RRT
   - Vascular complications
   - Cerebrovascular complications
   - Infections
   - ECMO site issue
   - Cardiovascular arrest

BTT: risk factors

1. Major: almost certainly affect outcome
   - Additional organ dysfunction
   - Deconditionning
   - Retransplant

2. Minor: can be mitigated
   - Type of ECMO (except in the PH population, VV is associated with better outcomes)
   - Center volume / experience
   - Bridge duration
   - Underlying disease process
   - Infection

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Adapted from Nasir *et al.* CTR 2021.

Intraoperative ECMO

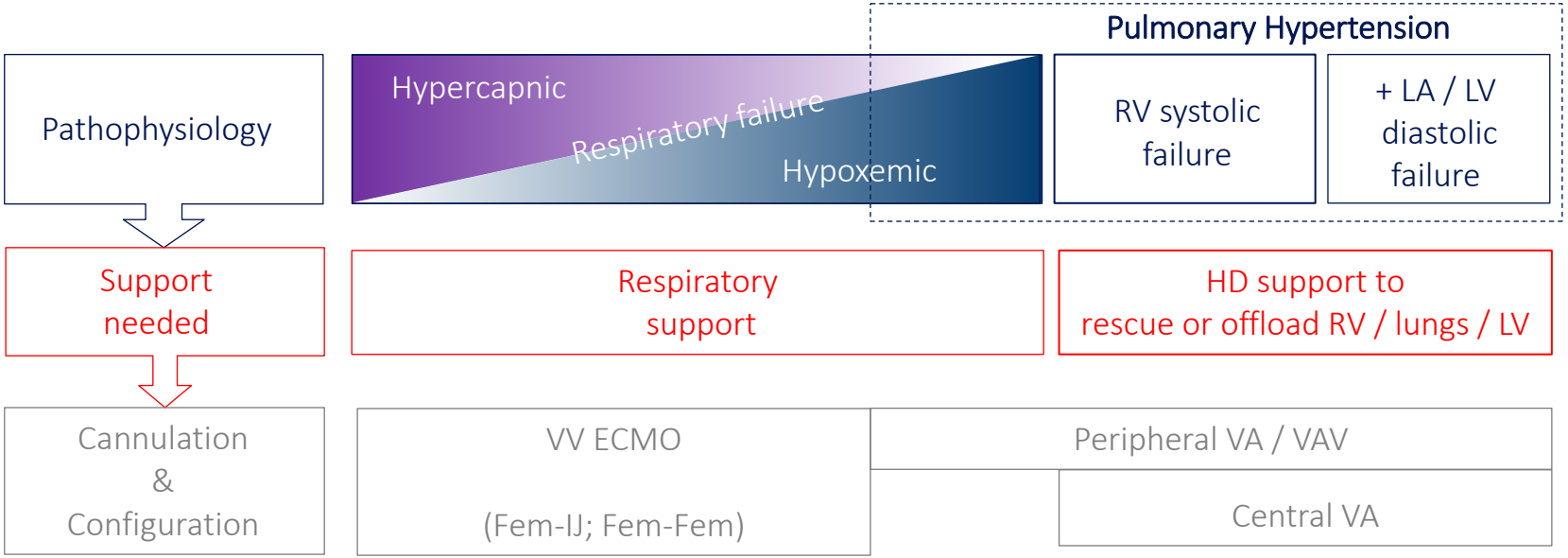
- **Indications:**
  1. BTT continuation
  2. Anticipated challenging induction in severe PH patients - awake ECMO cannulation for HD stability
  3. Unstable HD upon PA clamping
  4. Inadequate gas exchange upon single lung ventilation
  5. Failure of the first implanted lung
  6. Technical challenges

- **Strategies:**
  - ECMO
    - Peripheral or central VA for PAH or hemodynamic issues
    - VV for pure respiratory instability

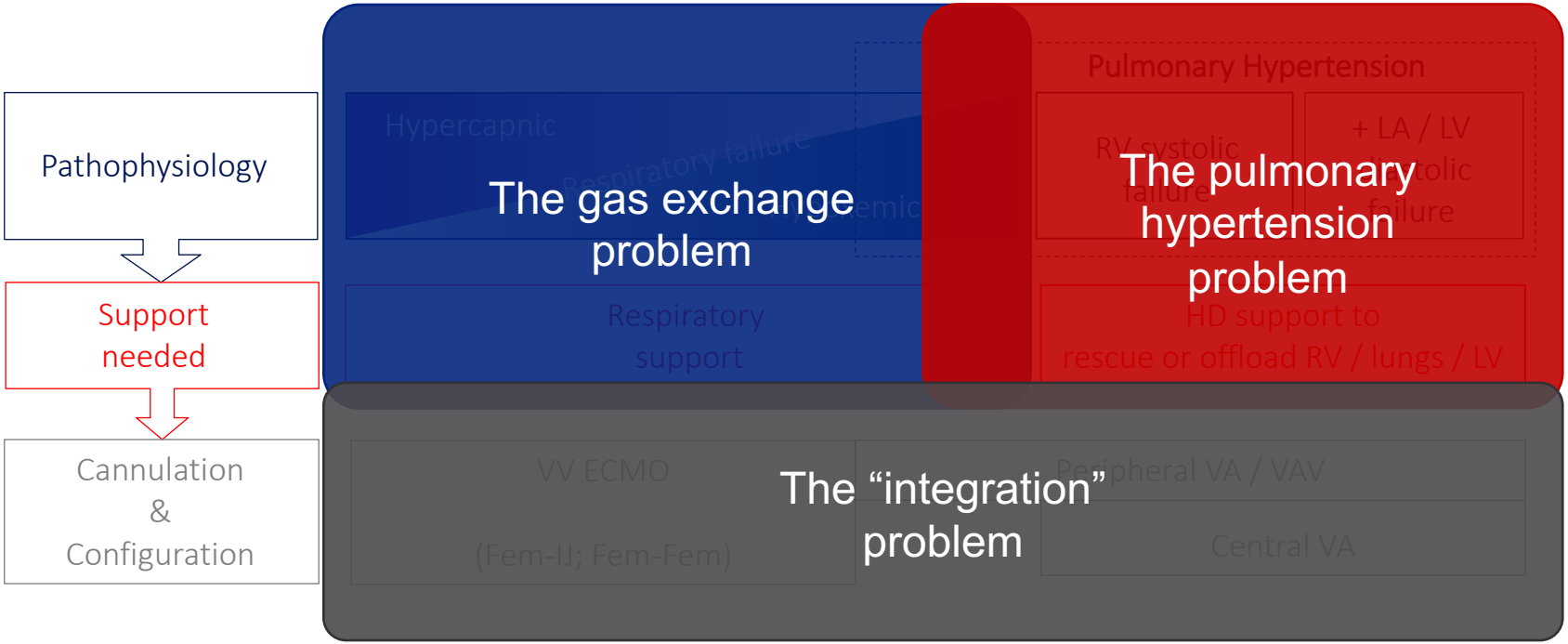
  VS

  - CPB

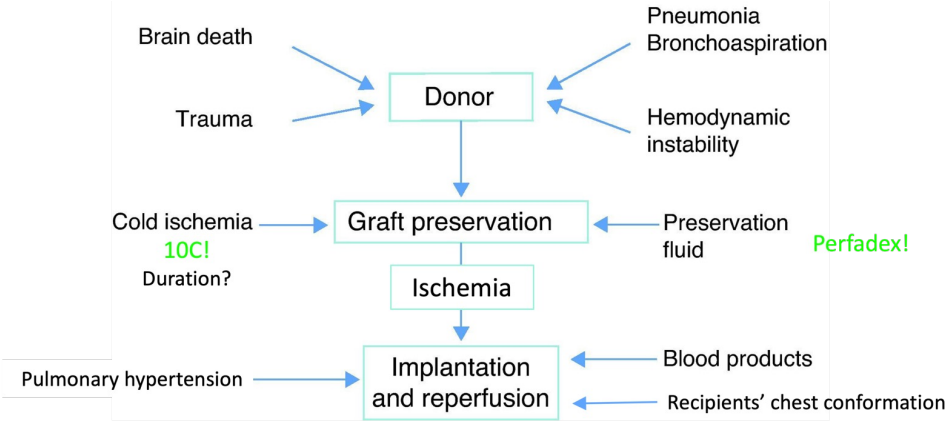
Postop ECMO: 3 problems



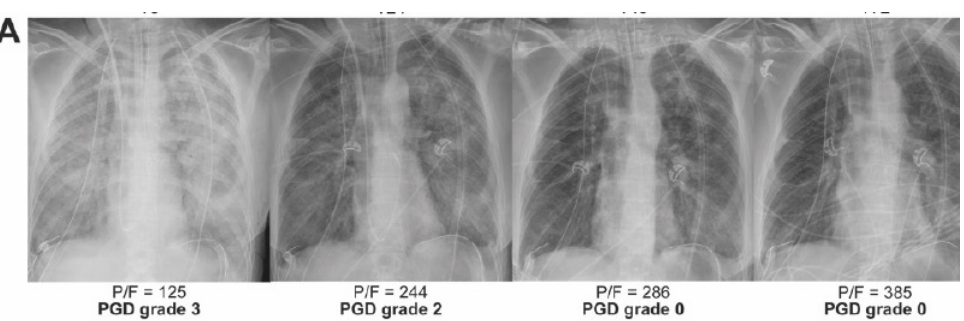
Postop ECMO: 3 problems

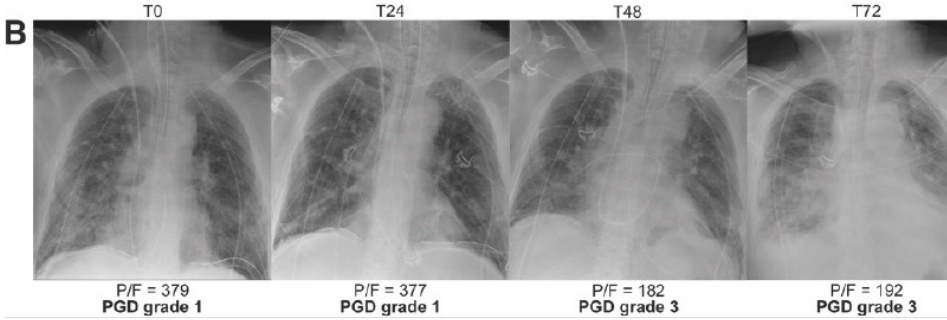


1. The gas exchange problem: "PGDs" in LTx



- Diverse biologic subsets
- Different endotypes
- Distinct clinical trajectories





Adapted from Suarez-Lopez *et al,* Med Int 2012; Shah et al, Chest 2013; Van Slambrouck *et al,* Cells 2022.

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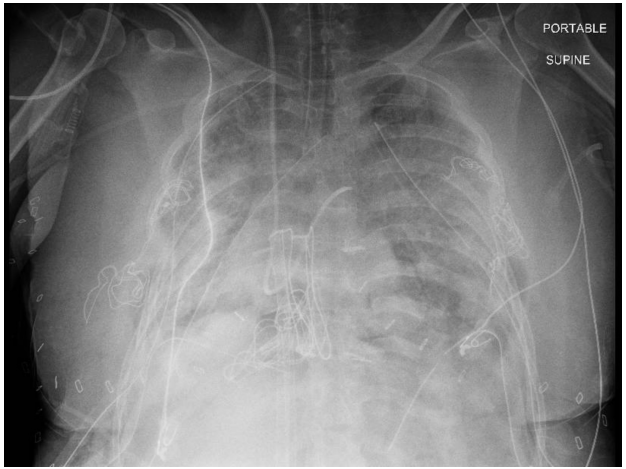

Grade	Pa_{O_2}/FI_{O_2}	Radiographic Infiltrates Consistent with Pulmonary Edema
0	>300	Absent
1	>300	Present
2	200–300	Present
3	<200	Present

No other choice!

- Dominantly a gas exchange issue > VV ECMO
- Increase in PVR may drive RV failure > VAV ECMO

Adapted from Snell *et al*, JHLT 2017

1. The gas exchange problem: "PGDs" in LTx

Grade	Pa_{O_2}/FI_{O_2}	Radiographic Infiltrates Consistent with Pulmonary Edema
0	>300	Absent
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Don't default to ECMO, rather **optimize V/Q**:

1. Use iNO or iEPO
2. Optimize ventilation
   - Bronch
   - FiO_2
   - PEEP (high BMI patients?)
3. Optimize intravascular filling
   - TEE
   - Swan
   - LAP
   - Other devices
4. Frequent re-evaluation

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Adapted from Snell *et al*, JHLT 2017

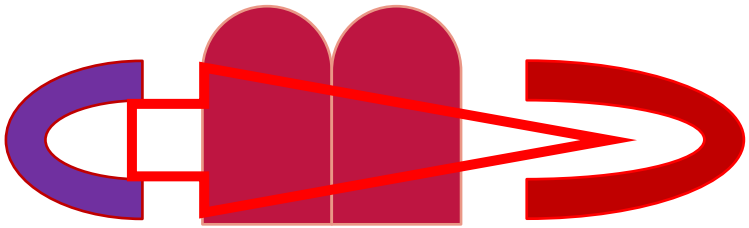
2. The pulmonary hypertension problem



Adapted from Moser *et al.* EJCTS 2017; Mercier *et al*, AATS 2026.

2. The pulmonary hypertension problem

Pre-transplant



High PVRs

High afterload

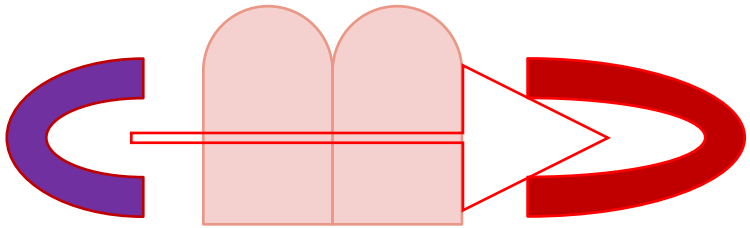
Elevated RVSP & filling pressures

Low preload

Underfilled LV

Low CO

Post-transplant



Low PVRs

Low afterload

RV filling?

Capillary leak

High preload

Diastolic dysfunction

High CO

Prolonged VA ECMO offloading
Adapt fluid balance
Slow wean

Adapted from Moser *et al.* EJCTS 2017; Mercier *et al*, AATS 2026.

2. The pulmonary hypertension problem

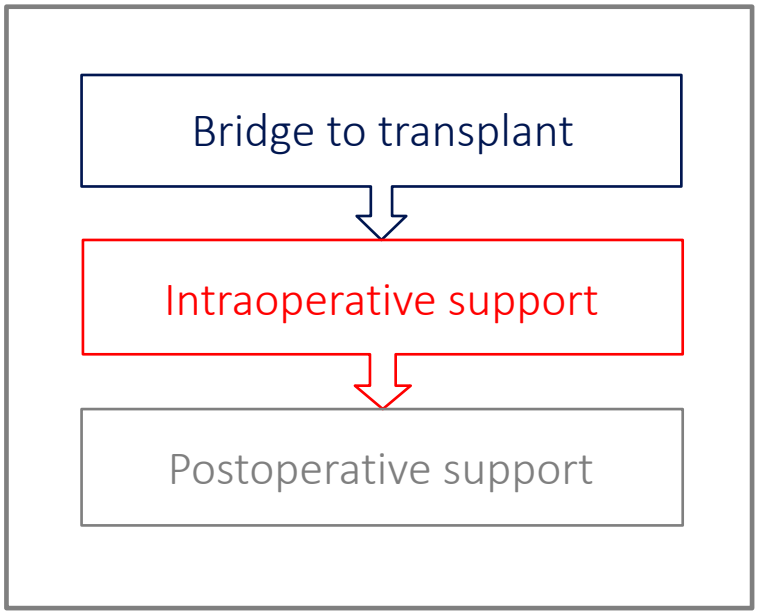
- Manage the unmasked left heart diastolic dysfunction + RV preload

- Prolonged VA ECMO offloading
  - Maintain transpulmonary flow for bronchial perfusion
  - Duration depending on PH level and group: can be shorter in group 3 vs group 1
  - Adapt fluid balance
  - Slow wean
  - Monitoring is critical
    - Swan
    - TEE
    - LAP

- Not all will need VA ECMO
  - Careful volume status monitoring
  - Use inotropes / pressors / pulm vaso dilat
  - Experience
  - VV may be enough? Or no ECMO at all?

Adapted from Moser *et al.* EJCTS 2017; Mercier *et al*, AATS 2026.

3. The integration problem



<u>The bigger picture:</u>

1. Program experience
   - Volume
   - Case mix
2. Surgeon's experience / preference
3. Local resources

Take home messages

- ECMO offers a versatile cardiopulmonary support essential in the modern lung transplant surgeon's toolbox
- Cannulation strategy dictates the support delivered
- Support offered can be tailored to each patient's physiology, and adapted as needed
- Needs to be integrated in the "bigger picture**s**"

Thank you for your attention!

Please feel free to contact me:

