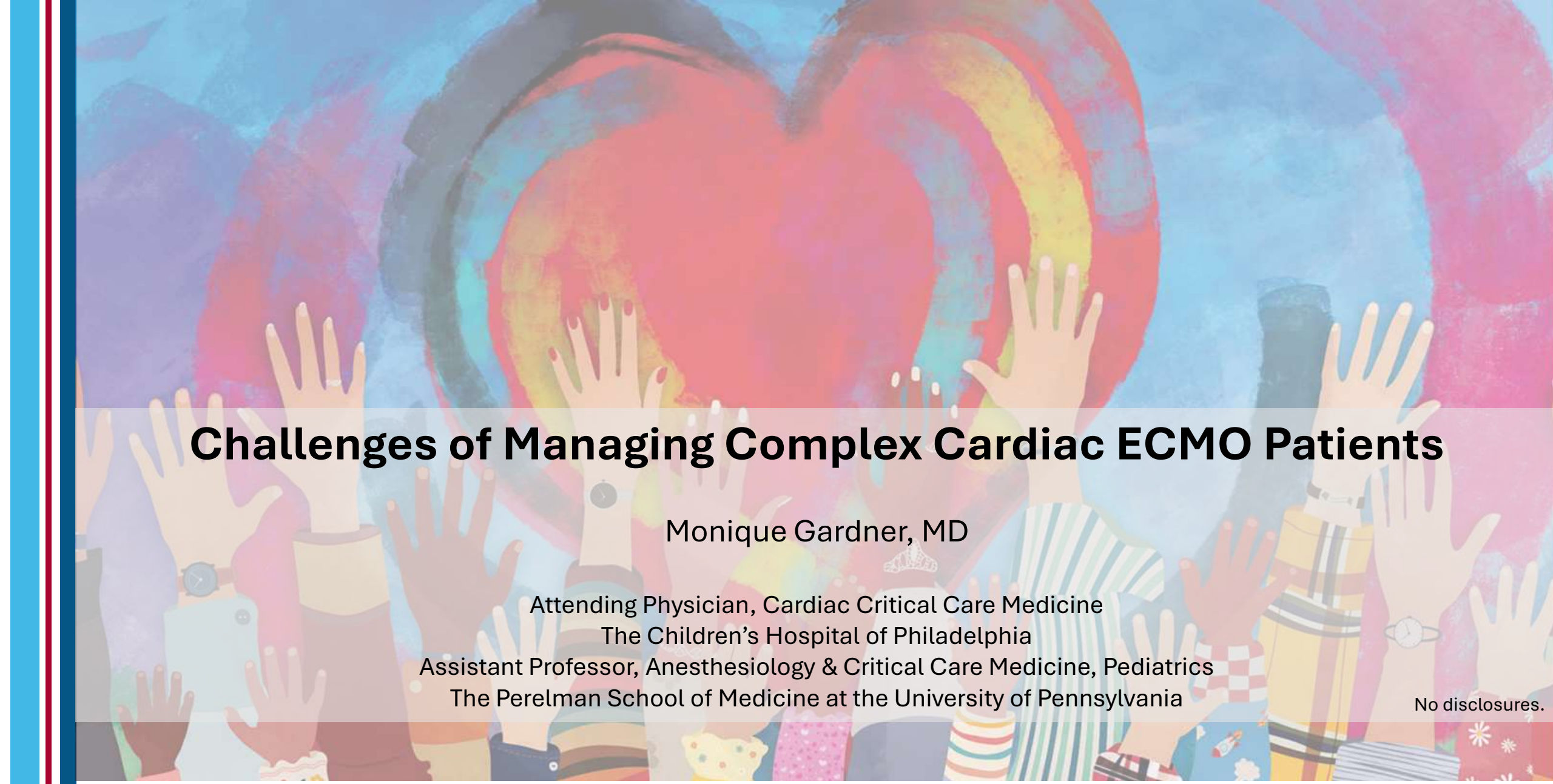

Challenges of Managing Complex Cardiac ECMO Patients

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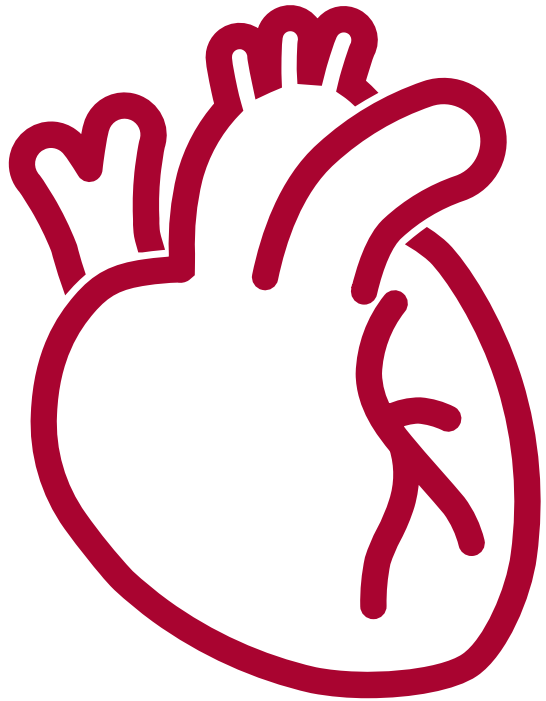
Overview: Challenging ECMO patients

Challenges providing adequate cardiac output and cardiac rest:

- Single ventricle heart disease
  - Norwood circulation
  - Glenn / Hemi-Fontan circulation
  - Fontan circulation
- Left atrial decompression
- Other anatomic & physiologic considerations

ECMO support with single ventricle heart disease



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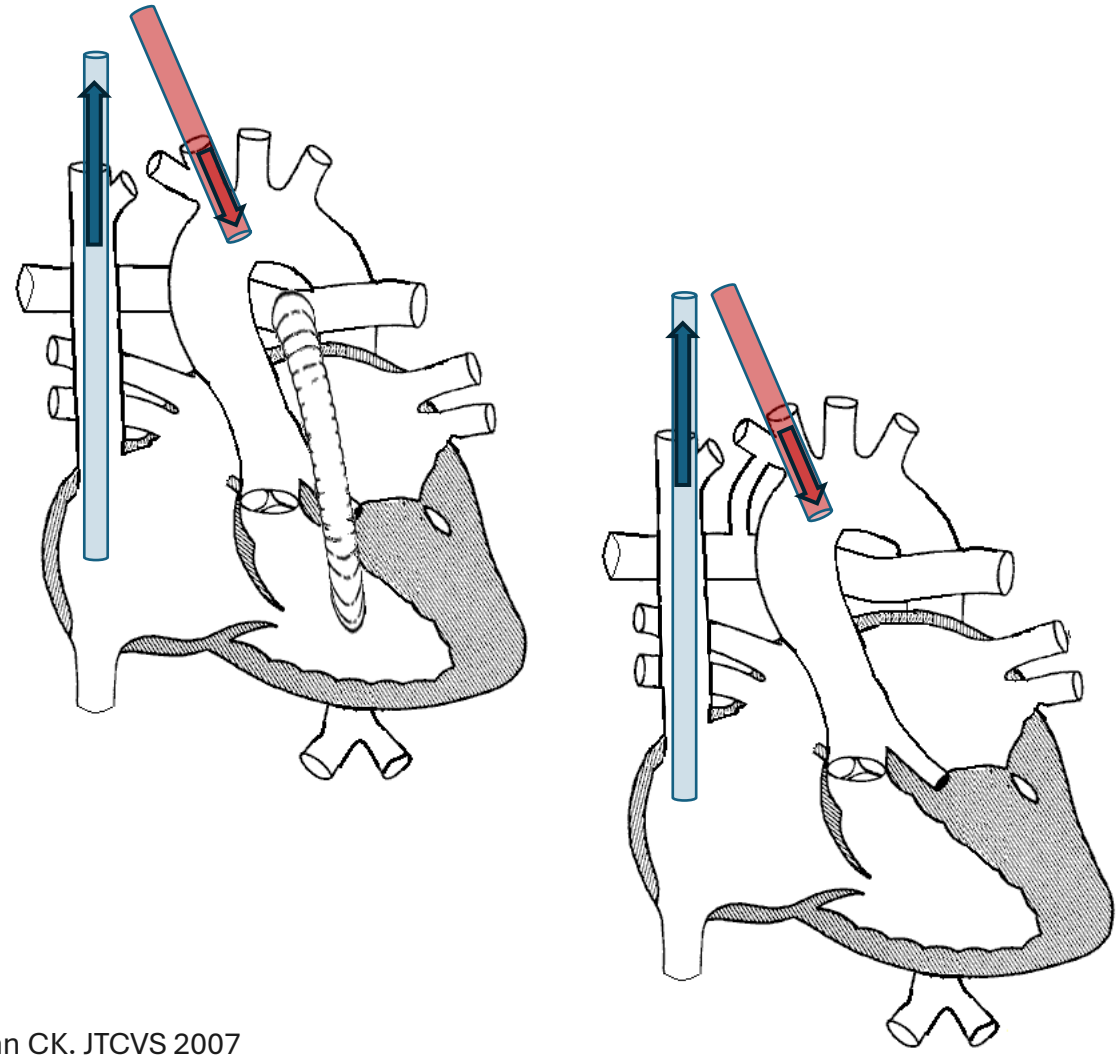
ECMO + Stage I Norwood circulation



- Supporting 2 circulations, frequently need higher flows (>120-150 mL/kg/min)
- Preferential flow to BTT shunt, causing systemic steal
  - May require BTT shunt banding
  - Will require de-banding prior to decannulation

Allan CK. JTCVS 2007
Bacon MK. Frontier Pediatrics 2018

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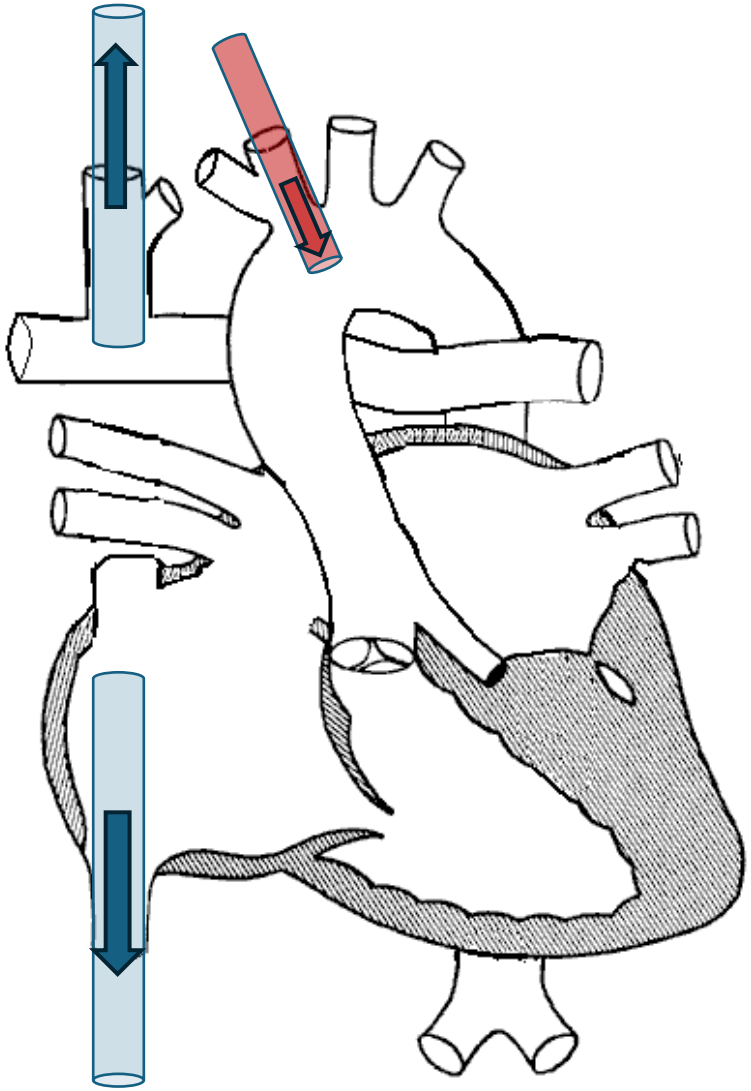
ECMO + Stage I Norwood circulation

- Frequently ECMO utilized in Norwood operation:
  - Failure to separate from bypass
  - E-CPR (ECMO canulation to achieve ROC in cardiac arrest)
- Survival higher than other SV ECMO
  - Reversible or transient causes
- Survival rates 30-40%

Allan CK. JTCVS 2007
Bacon MK. Frontier Pediatrics 2018

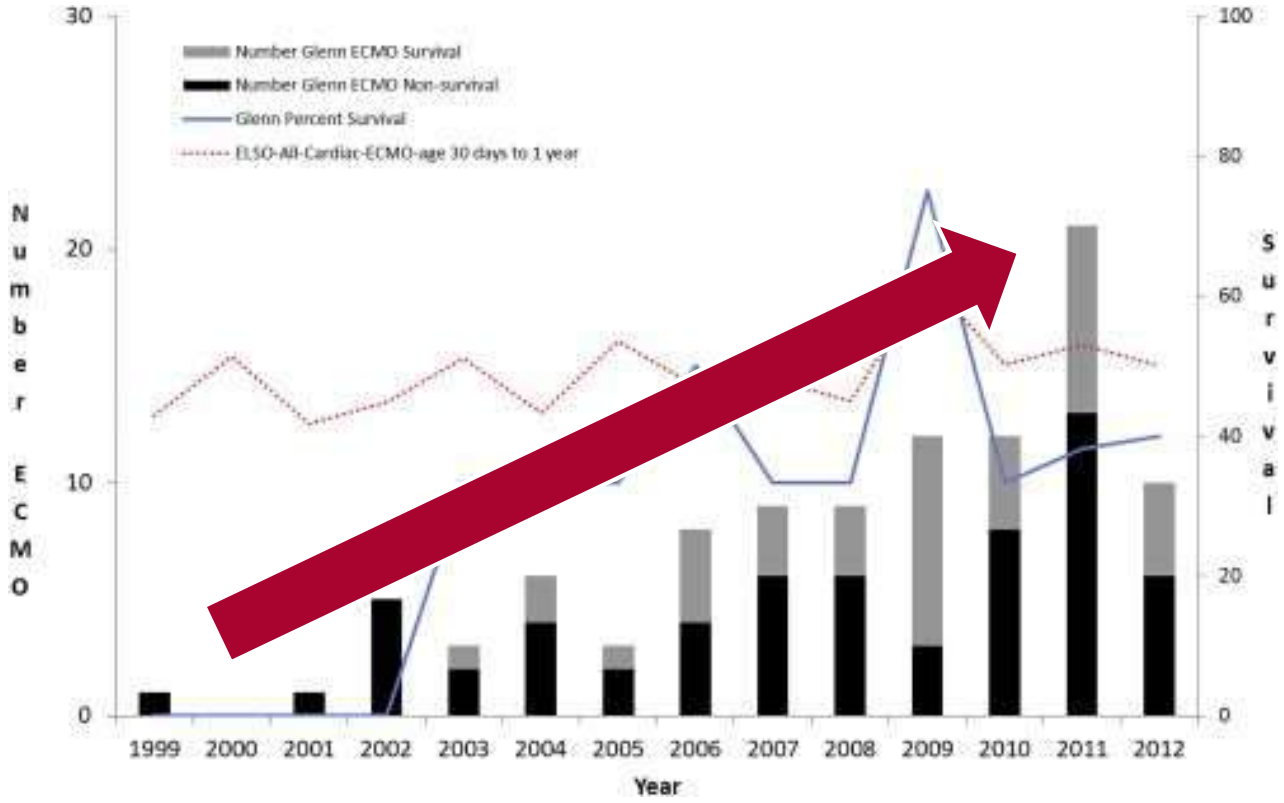
ECMO + Glenn/Hemi-Fontan circulation



- Circulation with SVC separated from heart
- Cannulation strategies can include:
  - Upper body primarily drained passively
  - May require second cannula in SVC for appropriate decompression
- Risk of brain injury with low cerebral perfusion pressure
  - Secondary to high Glenn pressure

ECMO + Glenn/Hemi-Fontan circulation

- Previously reported low rates of successful decannulation (50%) and 30% survival
- ECMO support with superior cavopulmonary connection has been increased in ELSO registry
- Increasing survival (42%) but with higher rates of neurologic injury
  - Seizures
  - Hemorrhage
  - Embolic stroke



Booth KL. ATS, 2004.

Jolley M. JTCVS, 2014.

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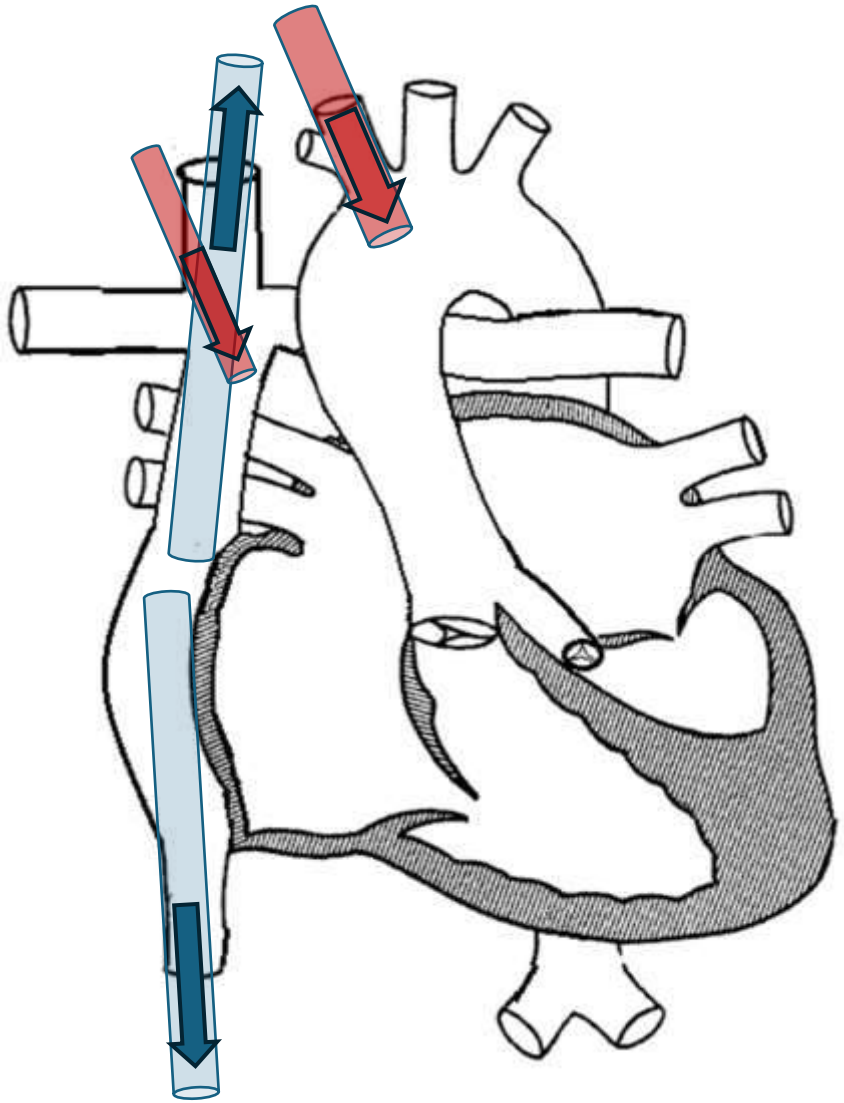
ECMO + Fontan circulation



- Venous cannulation can be via 1 (or 2) cannula
- Still dependent on functioning Fontan circulation
  - Open lung strategy
  - iNO to optimize PVR
- Sometimes V-A-A strategy utilized for some oxygenated blood to flow through Fontan

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ECMO + Fontan circulation

- Largest cohort of 230 subjects:
  - 35% survival of Fontan patients on ECMO (compared to ~50% of all cardiac ECMO)
- Single-center experience: 13 cases over 35 years (@ CHOP)
  - When ECMO used shortly after Fontan, higher survival and high rates of ECMO takedown
  - When ECMO utilized later after Fontan, high rate of mortality

Rood KL (JTCVS, 2011). Eichner & Edelson (unpublished data).

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Atrial Decompression Strategies

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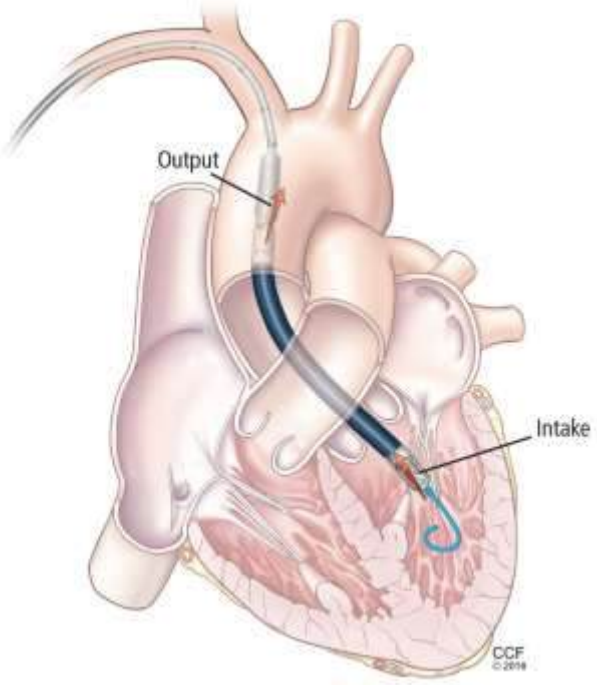
Atrial decompression

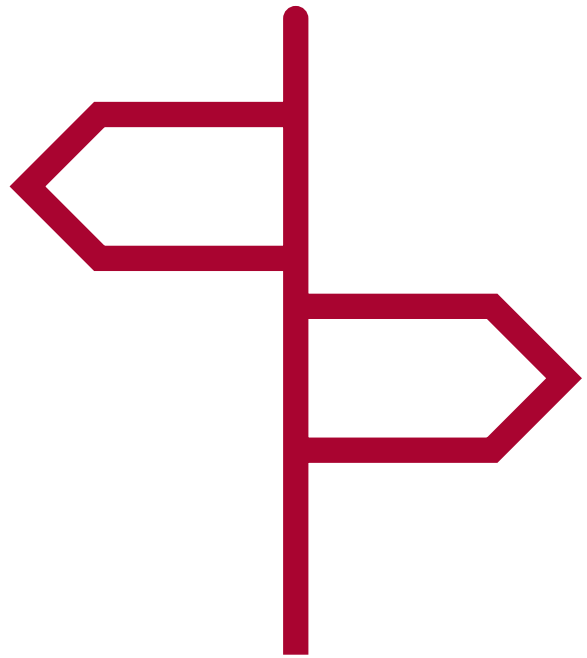
- Goals of atrial decompression:
  - Lower wall tension of LV
  - Lower left (common) atrial pressure to minimize LA pulmonary edema



Method	Benefits	Challenges
Balloon atrial septostomy	• Transcatheter approach	• Sometimes technically difficult • May be insufficient (atrial stent, septostomy) • Requires repair later
Left atrial venting	• Direct decompression • Able to adjust flow	• Difficult in smaller children; open chest considerations
IMPELLA	• Transcatheter/hybrid approach	• Limited to larger patients

Is there a better strategy?

- Difficult to compare strategies given different patient characteristics
- Atrial decompression seems to provide more benefit to myocarditis and cardiomyopathy ECMO cases
  - Survival benefit not seen in as strongly in CHD population
- Earlier decompression (<18 hours) may reduce ECMO duration and mechanical ventilation
  - No survival benefit demonstrated



Sperotto JAHA 2022
Zampi PCCM 2019

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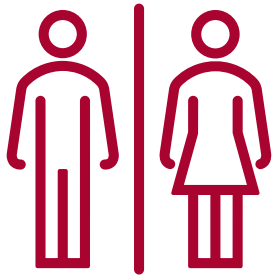
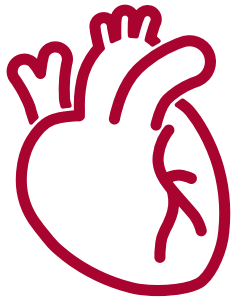
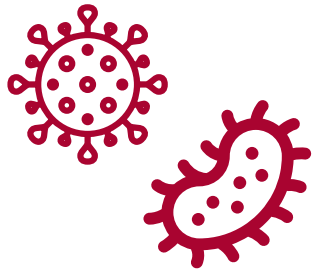
Other challenges…

ECMO support in large children	Anticoagulation strategies	Aortic insufficiency	Distributive shock	Withdrawal of ECMO support
• Femoral cannulation strategies • Retrograde aortic flow • Leg perfusion strategies	• Predominantly heparin-based • Considerations for bivalirudin	• Aortic cannula flow preferentially goes back in (left) ventricle	• Venous return decreased • Cutting out (venous cannula pressures) • Peripheral vasoconstrictors	• Brain death or non-survivable end organ injury







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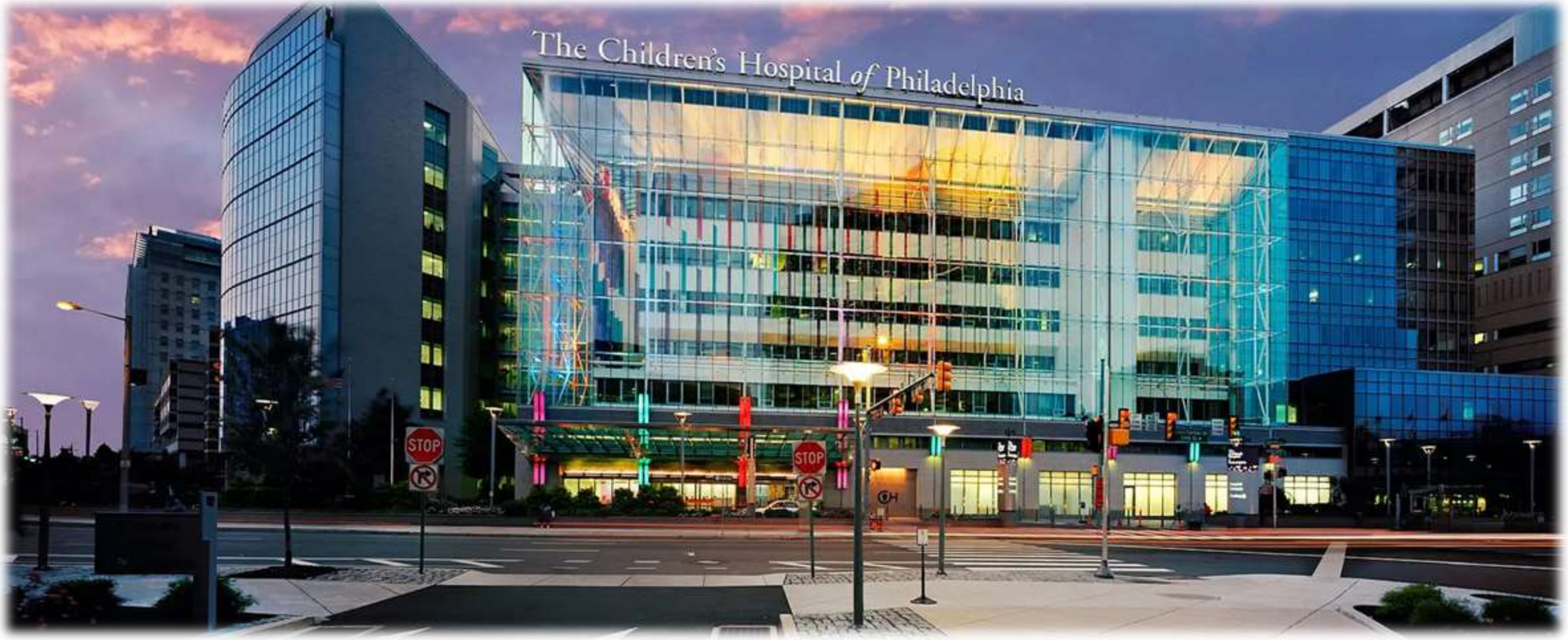
Thank You!



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