THE USE of VENTRICULAR ASSIST DEVICES in CHILDREN: CURRENT OPTIONS & FUTURE TRENDS

Ventricular Assist Devices in Children

- ADULTS : *VAD Better Accepted*
  - Technically easier
  - Fewer anatomical constraints
  - HTx is realistic possibility
  - Overall experience

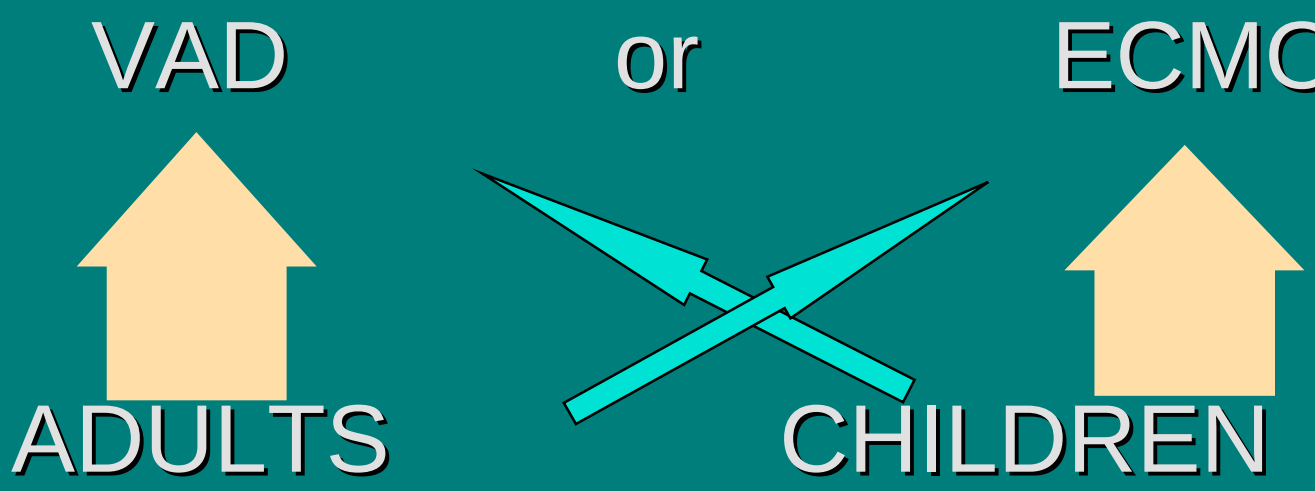
Ventricular Assist Devices in Children

- Farrar, Hill, Pennington et al.
  - J. Thorac.. Cardiovasc. Surg. 1997, 113(1), p 202
  - Cohort of 213 pts. in 35 centres
  - LVAD / RVAD / BiVAD or combo
  - 58% - 75% survival (all HTx)
  - Survival after HTx > 81%

Ventricular Assist Devices in Children

- CHILDREN : *VAD Less Well Accepted*
  - ? Technically difficult
  - ? Some anatomy unsuitable
  - Less experience
  - HTx less likely
  - Defined contraindications
  - ECMO for pulmonary dysfunction widely accepted

Ventricular Assist Devices in Children



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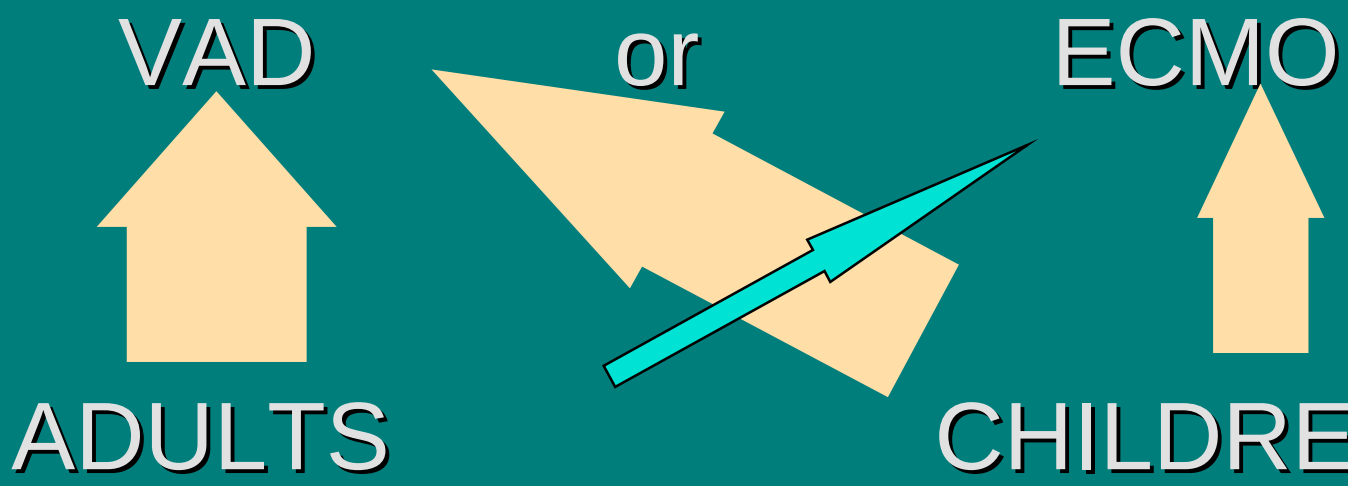
Ventricular Assist Devices in Children

....if Nil Contraindications....

Then Paediatric VAD *SHOULD* be Successful - and *MIGHT* be Better Than ECMO



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Ventricular Assist Devices in Children

- VAD IS:
  - Simpler
  - Associated with less bleeding
  - Associated with fewer patient complications
  - Associated with fewer circuit complications
  - Less expensive
  - More children are weaned

    (but no more survive)

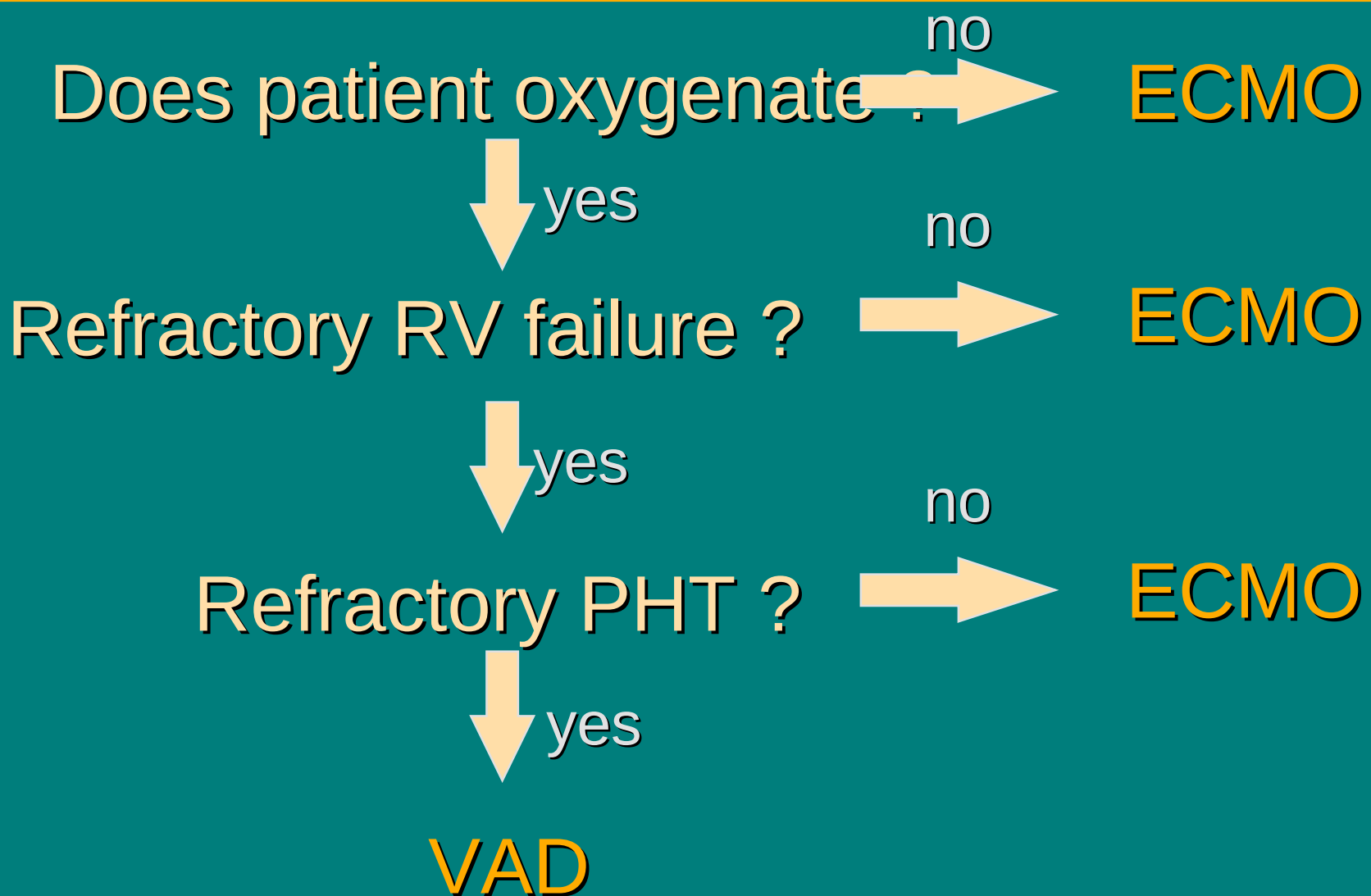
Ventricular Assist Devices in Children

- Indications for VAD
  - Unweanable from CPB
  - Weanable / weaned, but low cardiac output
  - Low cardiac output, not related to surgery
    - i.e.. recovery expected
  - Bridge to transplant
    - i.e.. recovery not expected

Ventricular Assist Devices in Children

- VAD or ECMO - that *IS* the question.....
  - either in OR or ICU
    - , adequate oxygenation
    - , no RV failure
    - , no pulmonary hypertension
  - Three , = VAD
  - One ***X*** = ECMO

Ventricular Assist Devices in Children



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Ventricular Assist Devices in Children

RCH VAD 1989-1997

Procedure	Patients
Norwood operation	10
Valve repair / replacement	9
Arterial switch operation	7
ALCAPA repair	5
Konno	3
Aortic root replacement	3
Supravalvar AS repair	2
HTx / HLTx	2
Bidirectional CP shunt	2
Miscellaneous	5

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SOTO et.al. 1997

Ventricular Assist Devices in Children

RCH VAD 1989-1997

- Univentricular vs biventricular repair p = 0.29
- Definitive vs palliative repair p = 0.29
- Age < 1 year p = 0.13
- Weight < 6 Kg p = 0.35

SOTO et.al. 1997

Ventricular Assist Devices in Children

- Berlin Heart
  - Paracorporeal, pneumatic
  - 10, 25, 30 ml stroke volume
  - Trileaflet polyurethane valves

Ventricular Assist Devices in Children

- Centrifugal pumps
  - Biomedicus, Sarns-Delphin, SJM-Lifstream
  - Non-occlusive
    - Preload and afterload dependant

Ventricular Assist Devices in Children

- Medos / HIA
  - Paracorporeal, pneumatic
  - 9, 10, 22.5, 25 ml stroke volumes
  - 12 & 16 mm trileaflet polyurethane valves
  - Touch-screen drive unit
  - Transparent
  - Seamless joints
  - CAD optimized washout

Ventricular Assist Devices in Children

Location	Author	Year	No. Pt's	No. Weaned	No. Disch.	Device
Texas	Scheinin	1994	9	77	55	CP; HP
Berlin	Hausdorf	1994	8	100	75	BH
Sydney	Costa	1995	13	76	53	CP; RP
Berlin	Ishino	1995	14	71	43	BH
Pittsburgh	Ashton	1995	9	89	44	CP; ABIO
Tokyo	Takano	1996	8	38	0	TOYOBO
Melb'rne	Soto	1997	48	71	46	CP
Bergamo	Glauber	1997	15	100	80	CP
Boston	Del Nido	1997	22	N/A	50	CP

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Ventricular Assist Devices in Children

RCH VAD experience: 1989-1997

- 48 patients (49 procedures)
- Median age: 3.5 months (2 days - 19 years)
- Median weight 4.7 kg (1.9 - 70 kg)
- 71% weaned

SOTO etal 1997

Ventricular Assist Devices in Children

- Kormos advocates
  - Better selection & appropriate timing

NOW	FUTURE
ICU	Discharge
Organ recovery	Full recovery
Large device	Portable / implantable
Non ambulatory	School / work
Short term	Months / years
HTx ASAP	HTx when optimal

Ventricular Assist Devices in Children

The Future.....

- Biomedicus
  - use of a Cray super computer for Computational Fluid Dynamics analysis
  - ? decrease haemolysis by 25%
  - other information confidential

Ventricular Assist Devices in Children

The Future.....

- Biomedicus - Heinrich Heine University
  - design of servoregulation system for inlet
  - Aim : increase safety
    limit effects of NVP

Ventricular Assist Devices in Children

The Future.....

- Abiomed
  - Research into paediatric version
  - 60 ml prime ; 500 - 1500 ml/min. flow
  - Adjustable stroke volume 5 - 15 ml
  - Status: animal experiments
  - Issues: anticoagulation; haematology; pulsatility

Ventricular Assist Devices in Children

The Future.....

- Jarvik
  - Axial flow
  - 1 x 4 cm; <70 gm
  - Flows to 3 lpm @ 10,000rpm
  - Bearing design - blood washed
  - ? transcutaneous energy supply
  - LV apex - Descending aorta
  - Status: Animal testing
  - Issues: power supply; thrombus

Ventricular Assist Devices in Children

The Future.....

- Pierce-Donachy
  - Aiming for <5 kg patients
  - Paracorporeal, pneumatic
  - ? need to alter 10mm bileaflet valves to lessen blood trauma
  - Improved flow patterns to facilitate
    - » better washing
    - » less thrombus

Ventricular Assist Devices in Children

The Future.....

- Mussivand - Univ. of Ottowa
  - Transcutaneous energy transference
  - Remotely programmable
  - Totally implantable
  - Status: prototype in animals
    paediatric size to come

Ventricular Assist Devices in Children

The Future.....

- Adults
  - Univ Utah centrifugal pump
  - Vienna Univ. sealless CP; ? implantable
  - Nimbus AxiPump
  - Medtronic Hemopump - new smaller size (<14FR)
  - Baylor Compact CP - uses ceramics & UHMW polyethelyne
  - DeBakey / NASA axial flow pump

Ventricular Assist Devices in Children

The Future.....

- Adults (con’t)
  - Univ. Pittsburgh Artificial Heart Programme
    - » Tiny Axial Flow pump in development