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GUVERNUL ROMÂNIEI



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Instrumente Structurale
2007-2013



GUVERNUL ROMÂNIEI
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OIRPOSDRU REGIUNEA CENTRU



UNIVERSITATEA DE MEDICINĂ ȘI
FARMACIE "CAROL DAVILA"
BUCUREȘTI

AD-COR Program inovativ de formare in domeniul cardiologiei pediatrice POSDRU/179/3.2/S/152012

Data: 17-09-2015

MODUL TEORETIC

Emergency in Neonatal Cardiac Surgery

Imputernicit: Prof. Dr. Tammam Youssef

Activitate prestata de I.R.C.C.S. POLICLINICO SAN DONATO – MILANO, ITALIA in
baza contractului nr. 18/22144/29.07.2015



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Acest material a fost documentat/ validat/ prezentat la sesiunile de formare în cadrul proiectului „AD-COR Program inovativ de formare în domeniul cardiologiei pediatrice” - POSDRU/179/3.2/S/152012, proiect cofinanțat din Fondul Social Operațional Sectorial Dezvoltarea Resurselor Umane 2007-2013.

Beneficiar: Universitatea de Medicină și Farmacie „Carol Davila” București

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Emergency in Neonatal Cardiac Surgery

*Alessandro Frigiola
Tammam Youssef*



IRCCS Policlinico San Donato



Physiologic, Hematologic,
Immunologic and Metabolic differences from adults

Newborn physiology

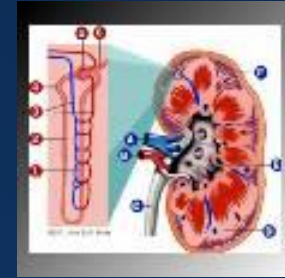
Multiorgan immaturity

- metabolic
- respiratory
- neurological
- renal
- myocardial



Total body water post CPB

600 – 1000 gm



Reduced Renal Function



Edema

Thorax

Lungs

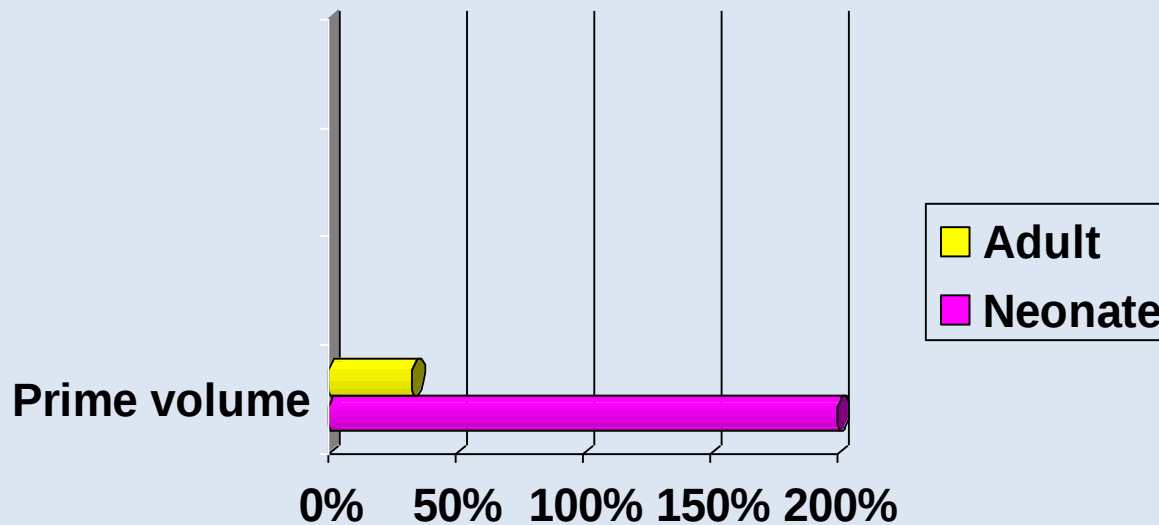
Myocardio

Reduced pulmonary compliance
Increased cardiac filling pressure

Circuit miniaturization

Control inflammatory response

Improved perfusion techniques



Congenital heart disease in Italy

3.000 new cases per year



40% with symptoms in the first month of life



Urgent cardiac procedures

Neonatal cardiac surgery procedures performed routinely

Coarctation repair

Systemic to pulmonary shunt

Patent ductus art. closure

Pulmonary artery banding

Norwood procedure for HLHS

Arterial switch operation

Truncus arterious repair

Interrrupted aortic arch repair

TAVPR repair

Aortic stenosis repair

Pulm. Stenosis or atresia with IVS repair

Initial therapeutic indications

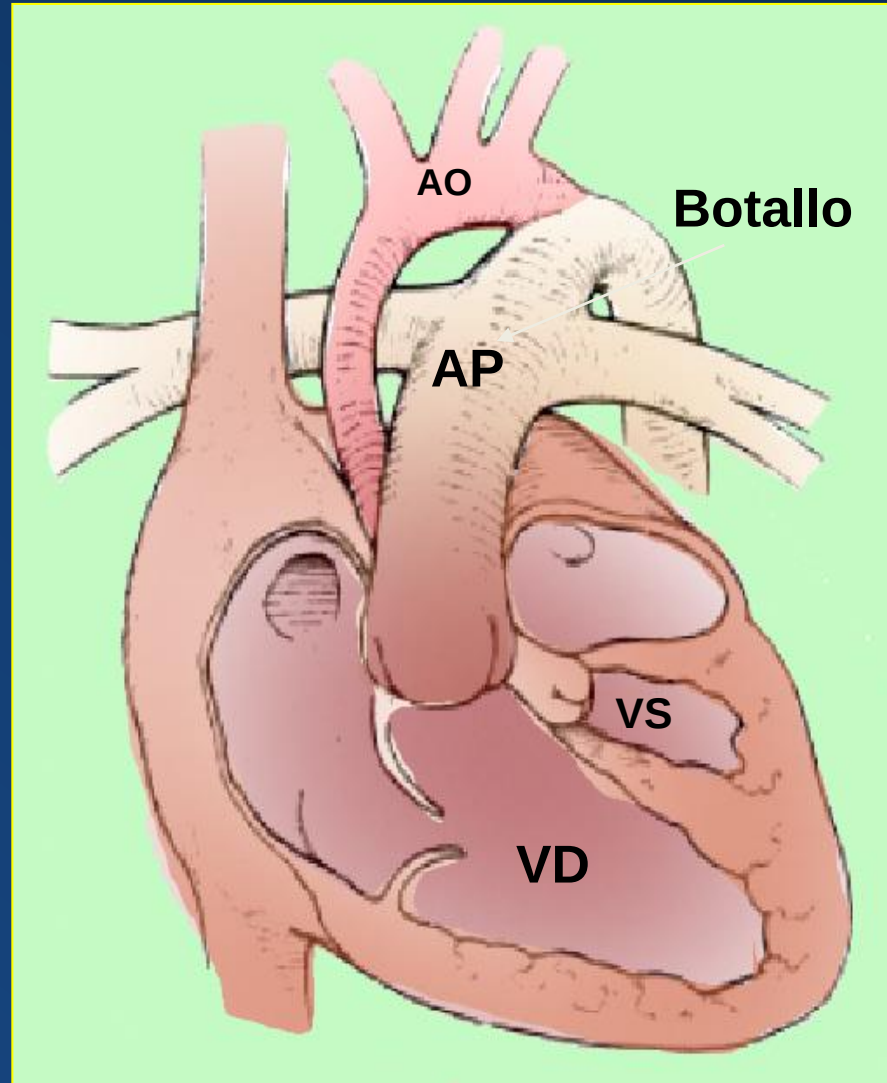
➤ **Surgery**

TGA	Switch
Hypoplastic left heart syndrome	Norwood
TAPVC	Correction
Coarctation	Anastomosi T-T
Aortic Arch Interruption	Correction

➤ **Hemodynamic procedures**

TGA	Atrial Septostomy
Aortic Stenosis	Valvuloplasty
PS or PA with intact IVS	Valvuloplasty

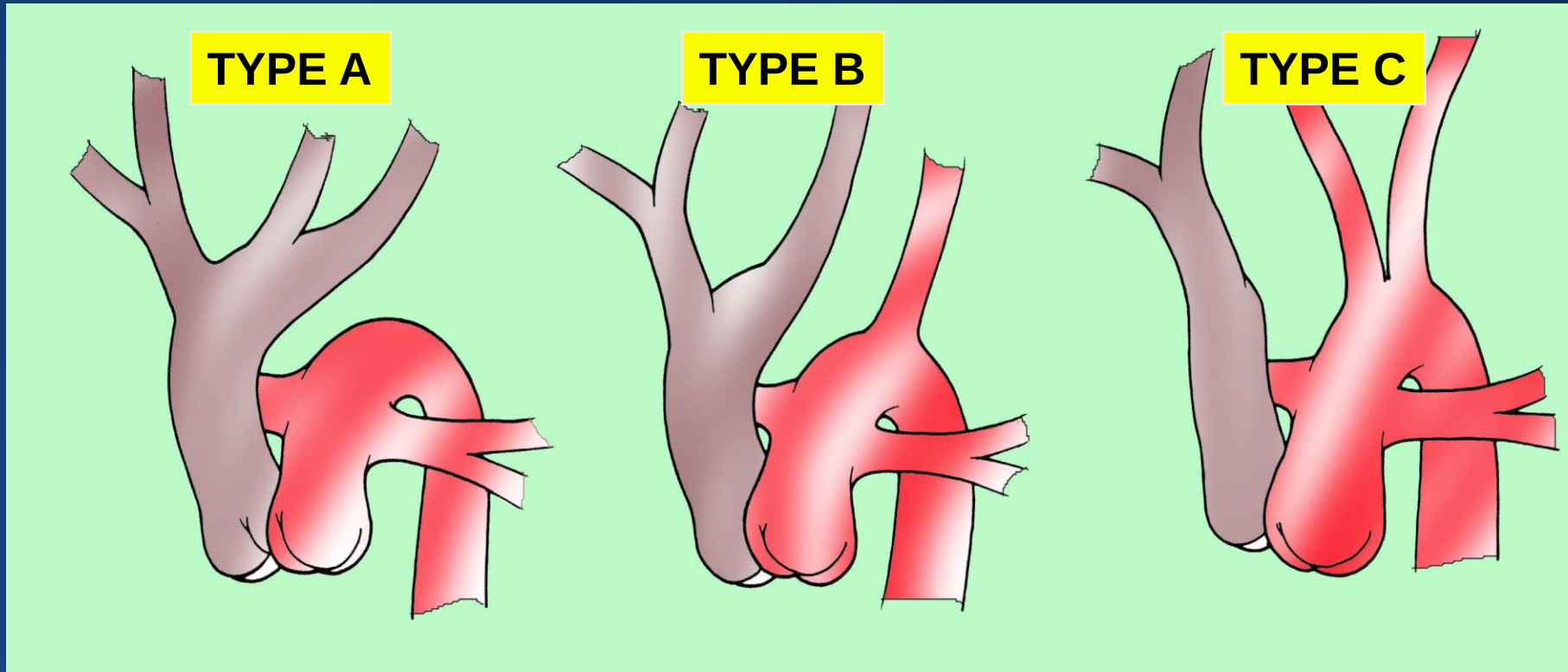
Hypoplastic heart syndrom



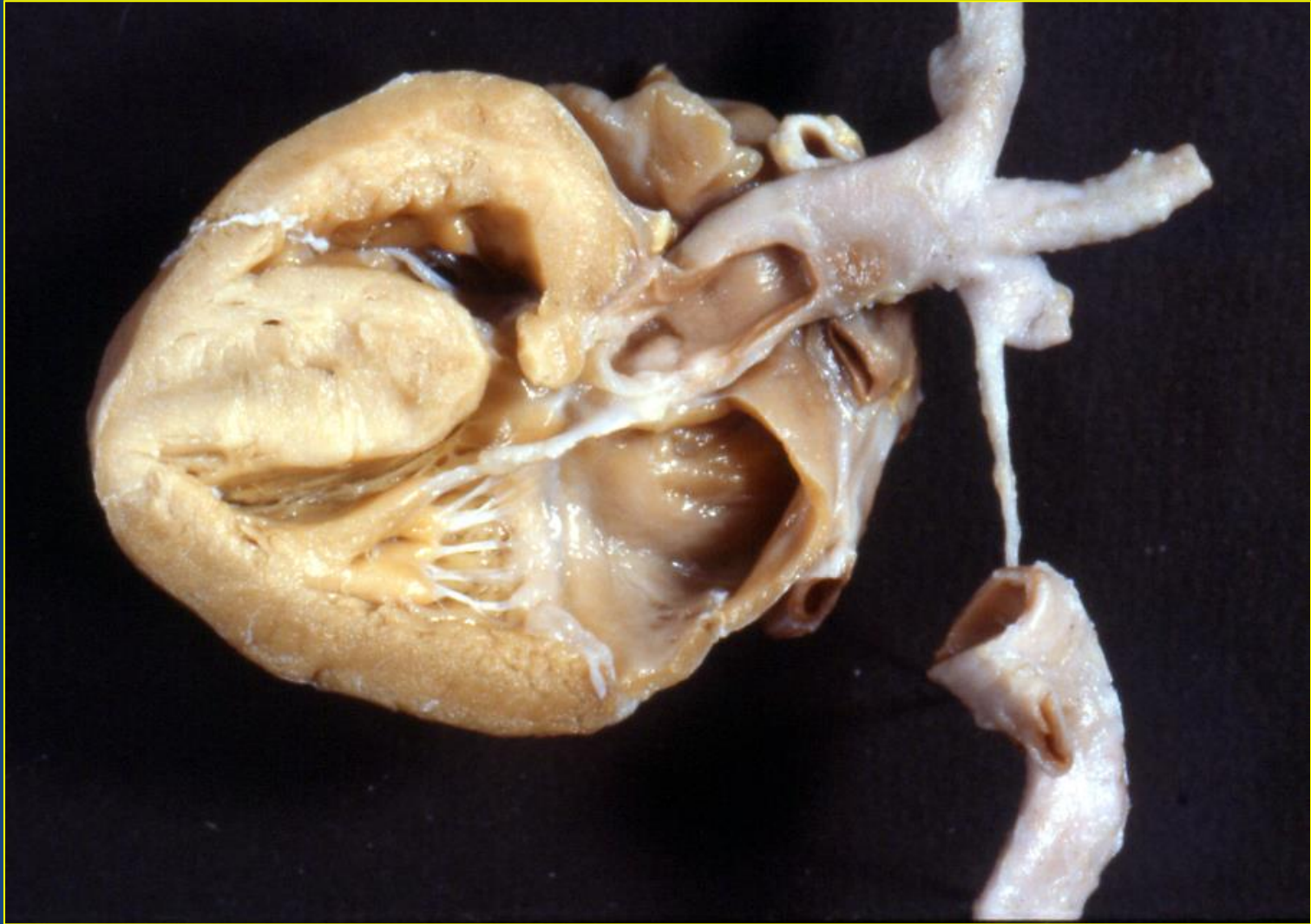
Hypoplastic heart syndrom (Norwood)



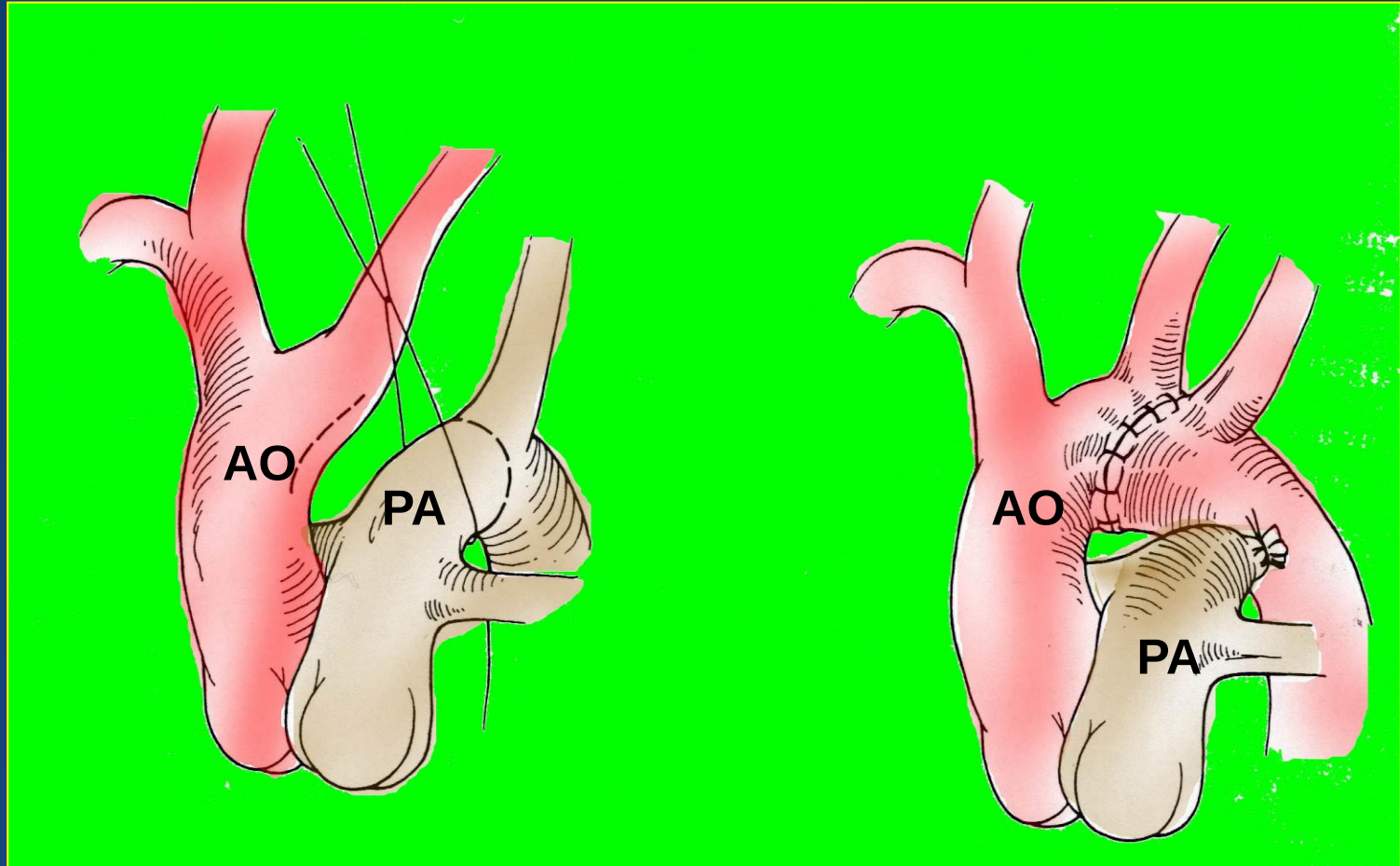
Aortic arch interruption



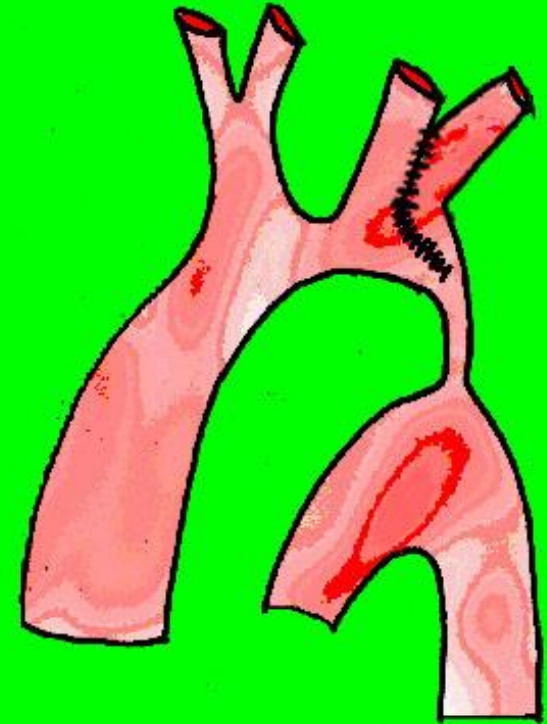
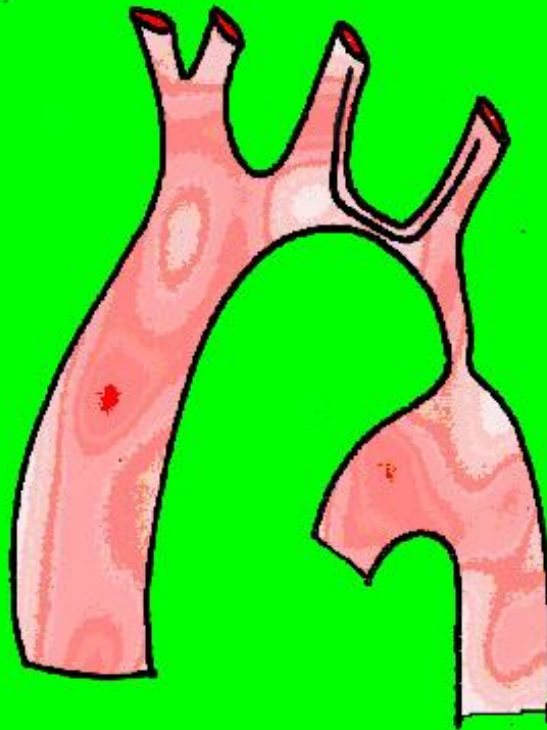
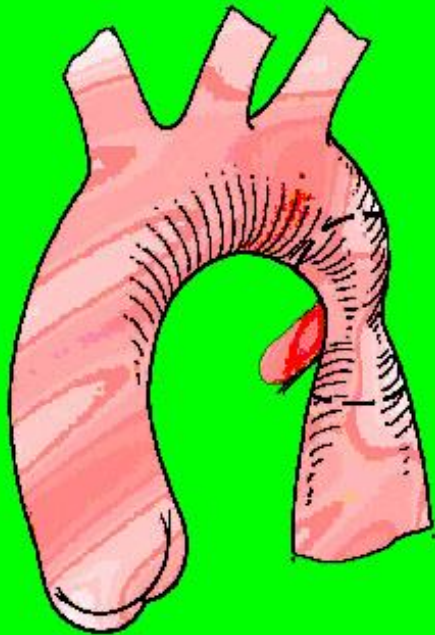
Aortic arch interruption



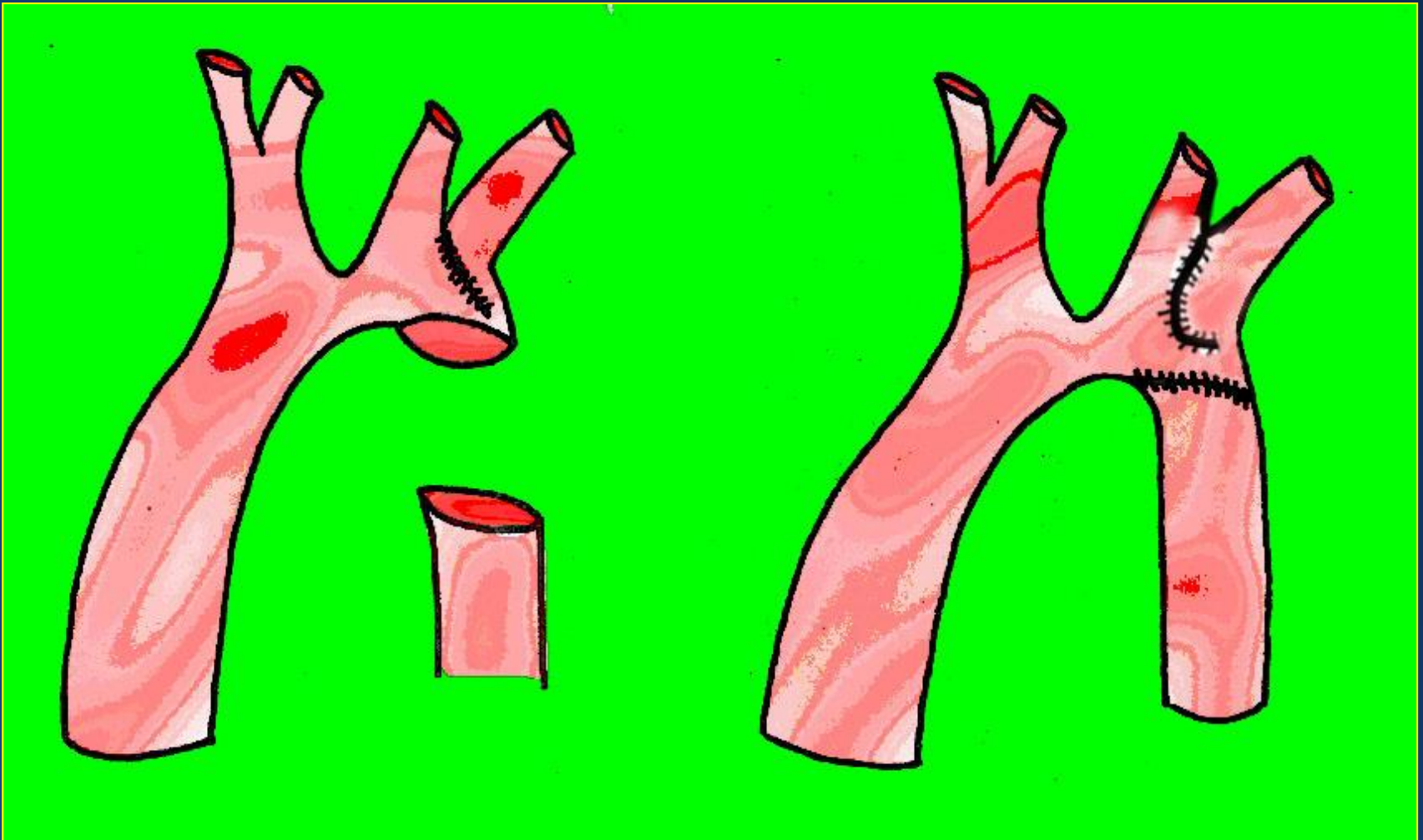
Aortic arch interruption



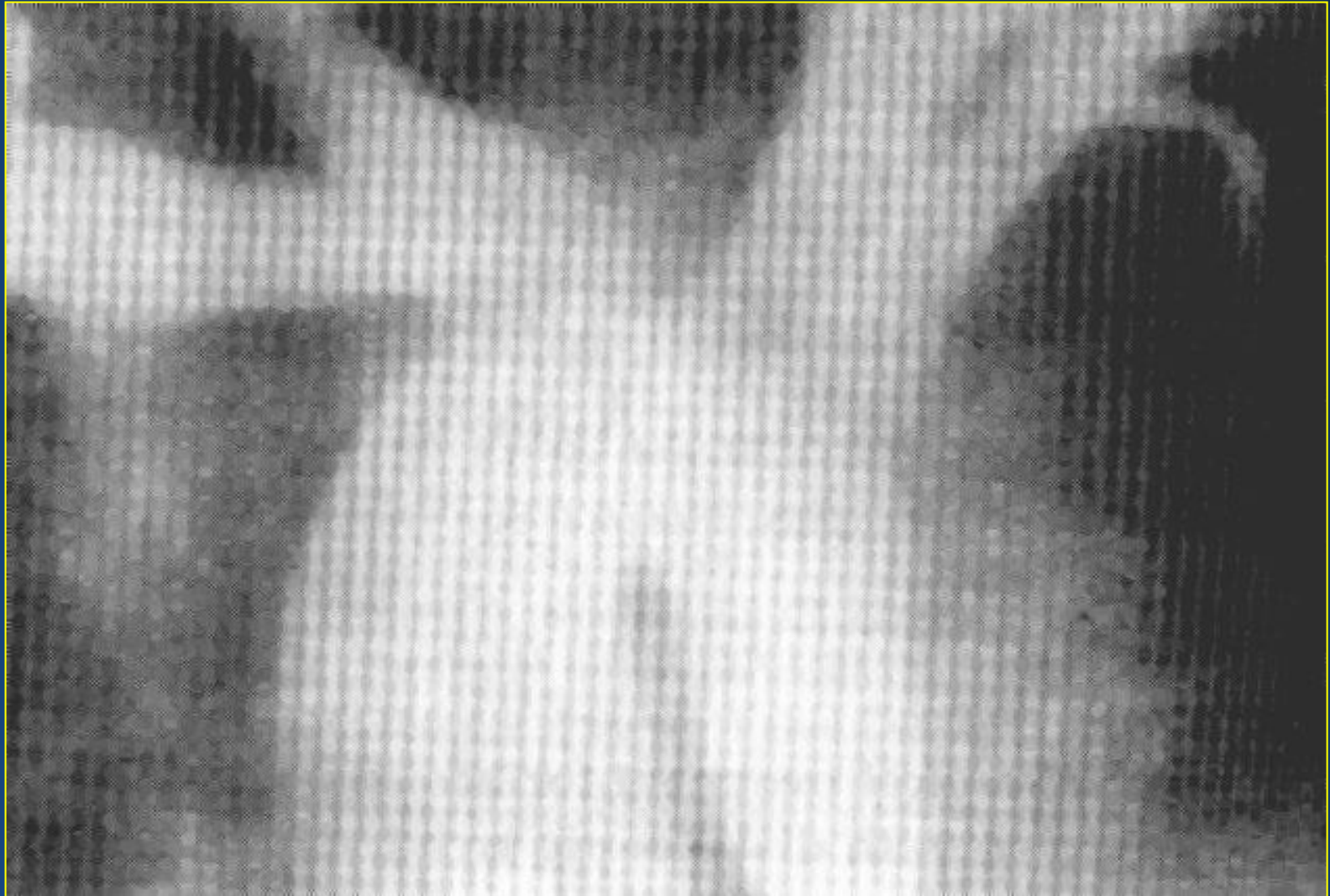
Aortic coarctation



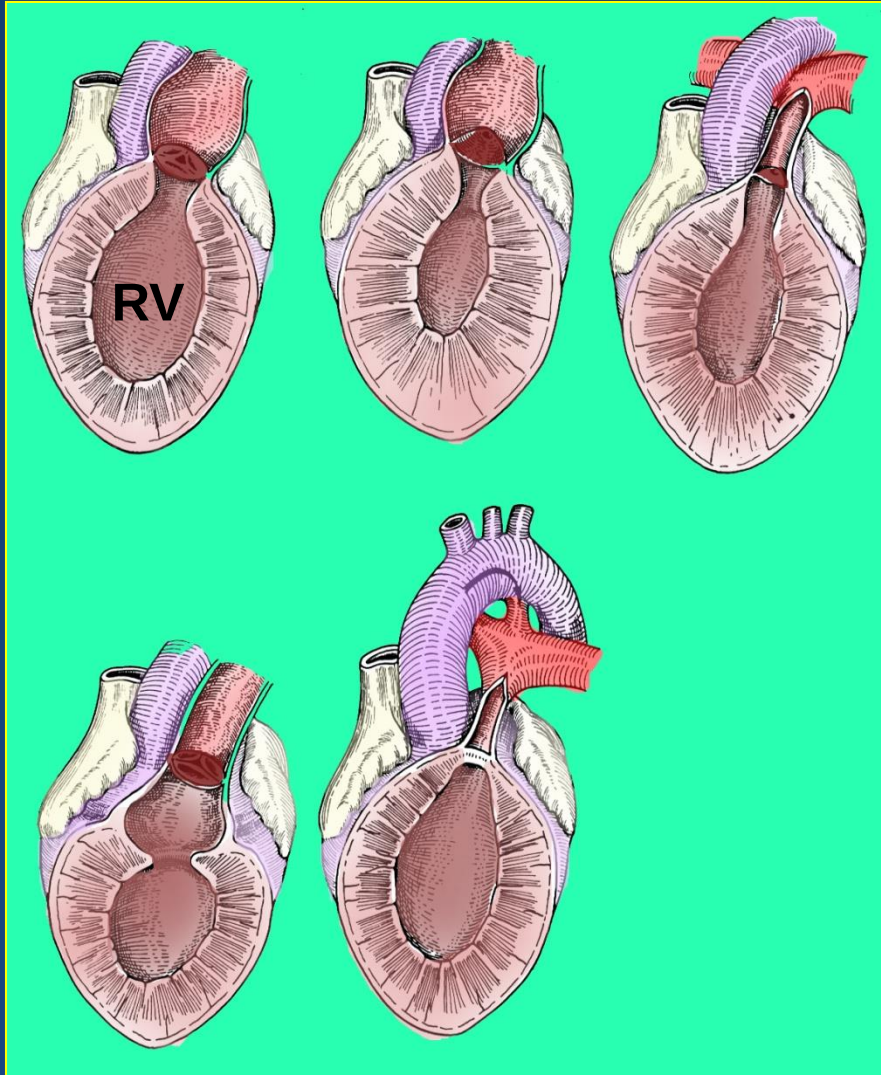
AORTIC COARCTATION WITH HYPOPLASTIC ARCH



Post-op angio



Pulmonary atresia with intact ventricular septum

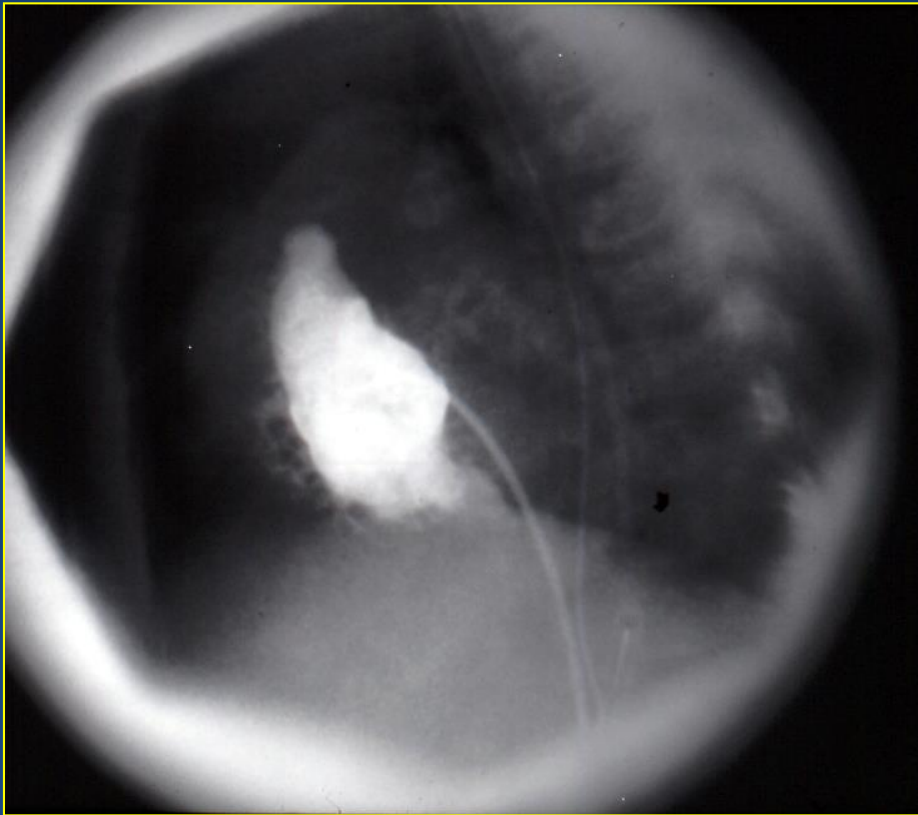


Post dilatation

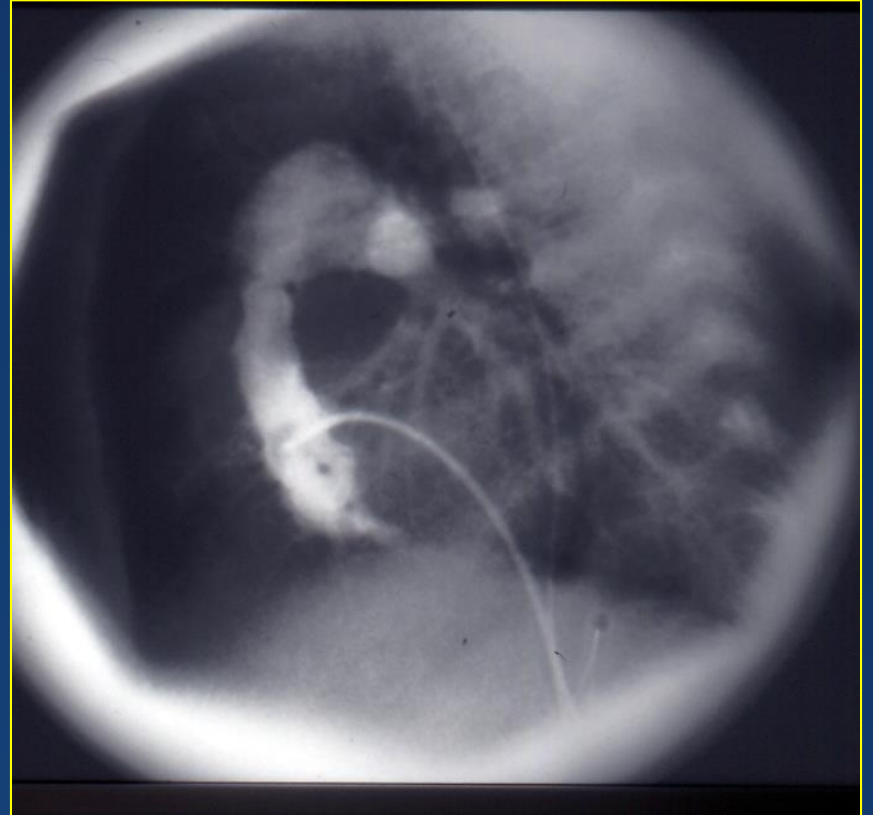


Critical Pulmonary Stenosis

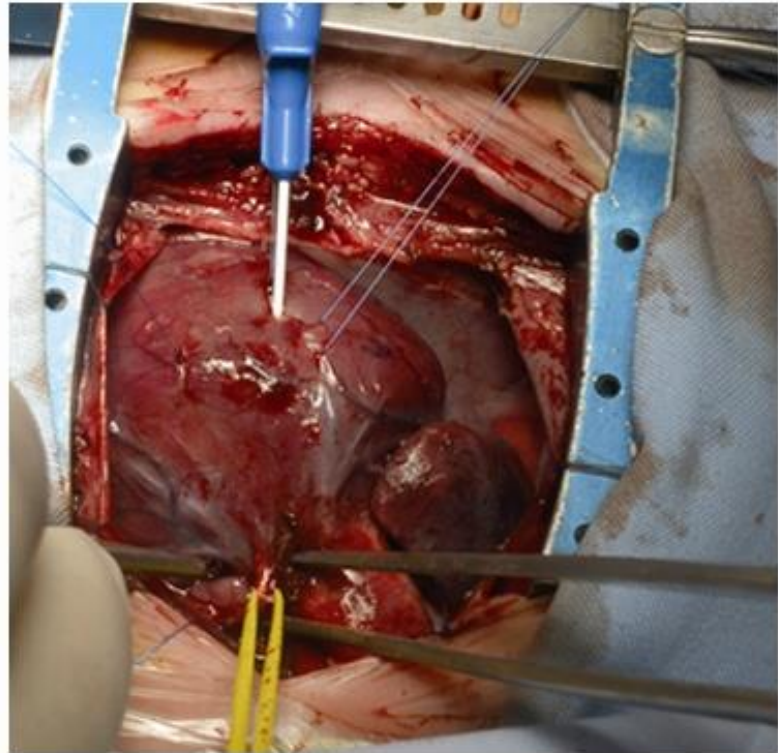
Pre-



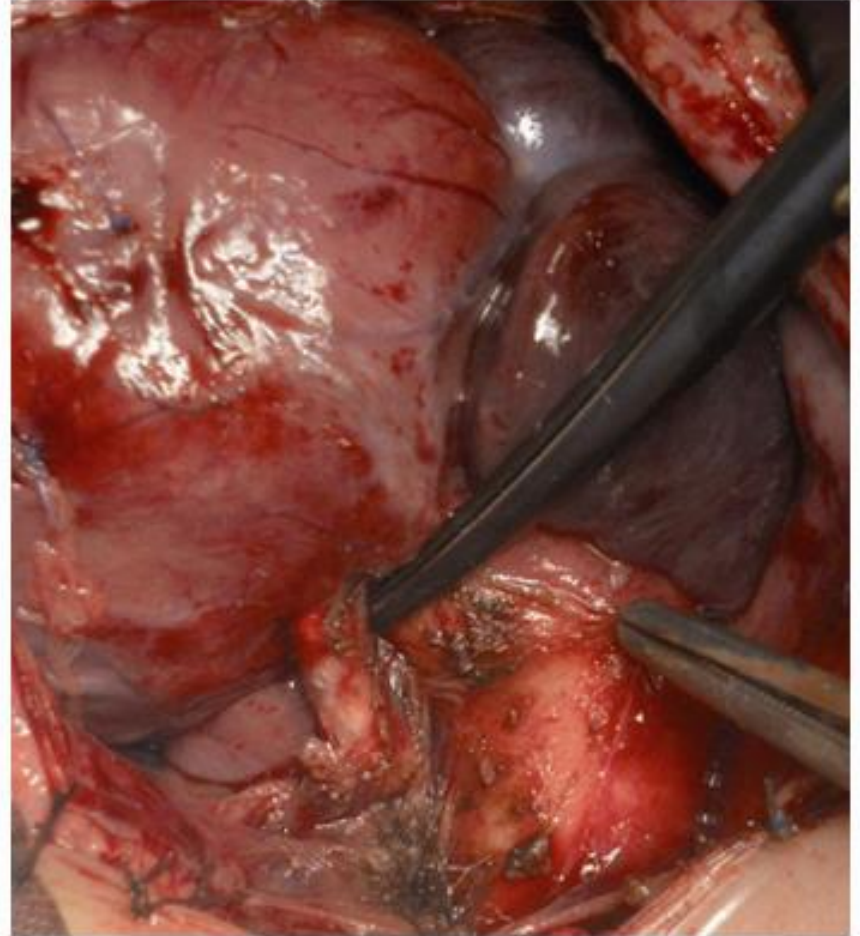
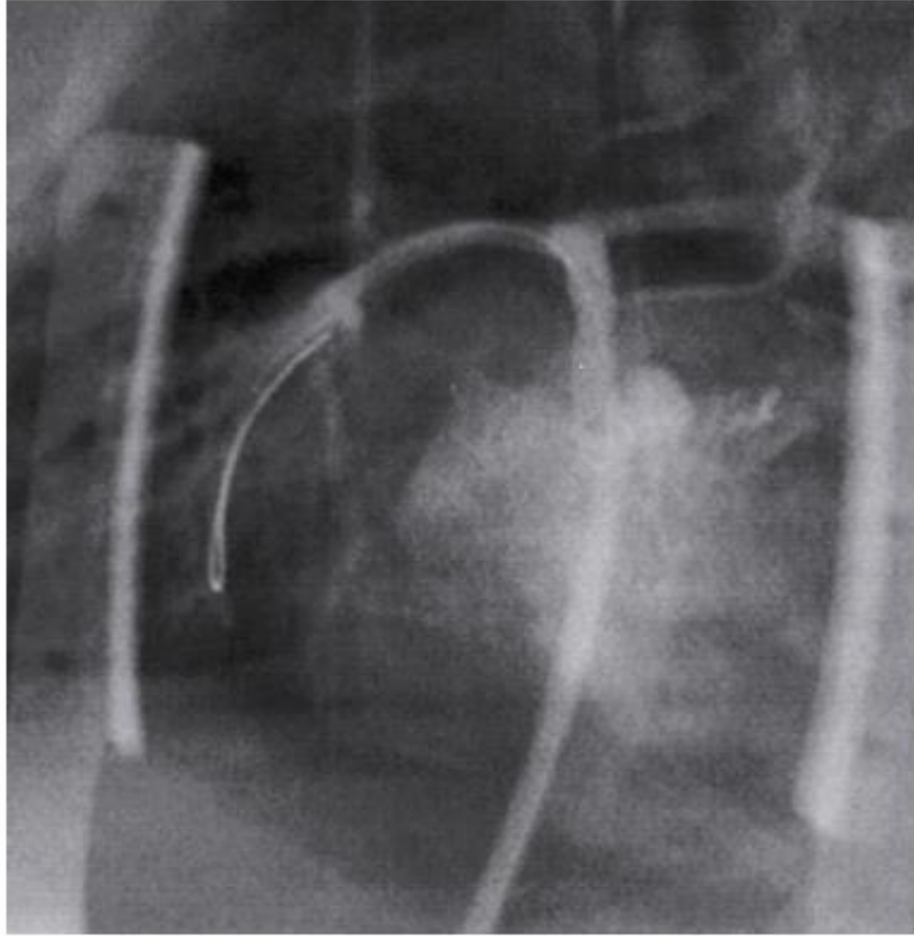
Post-



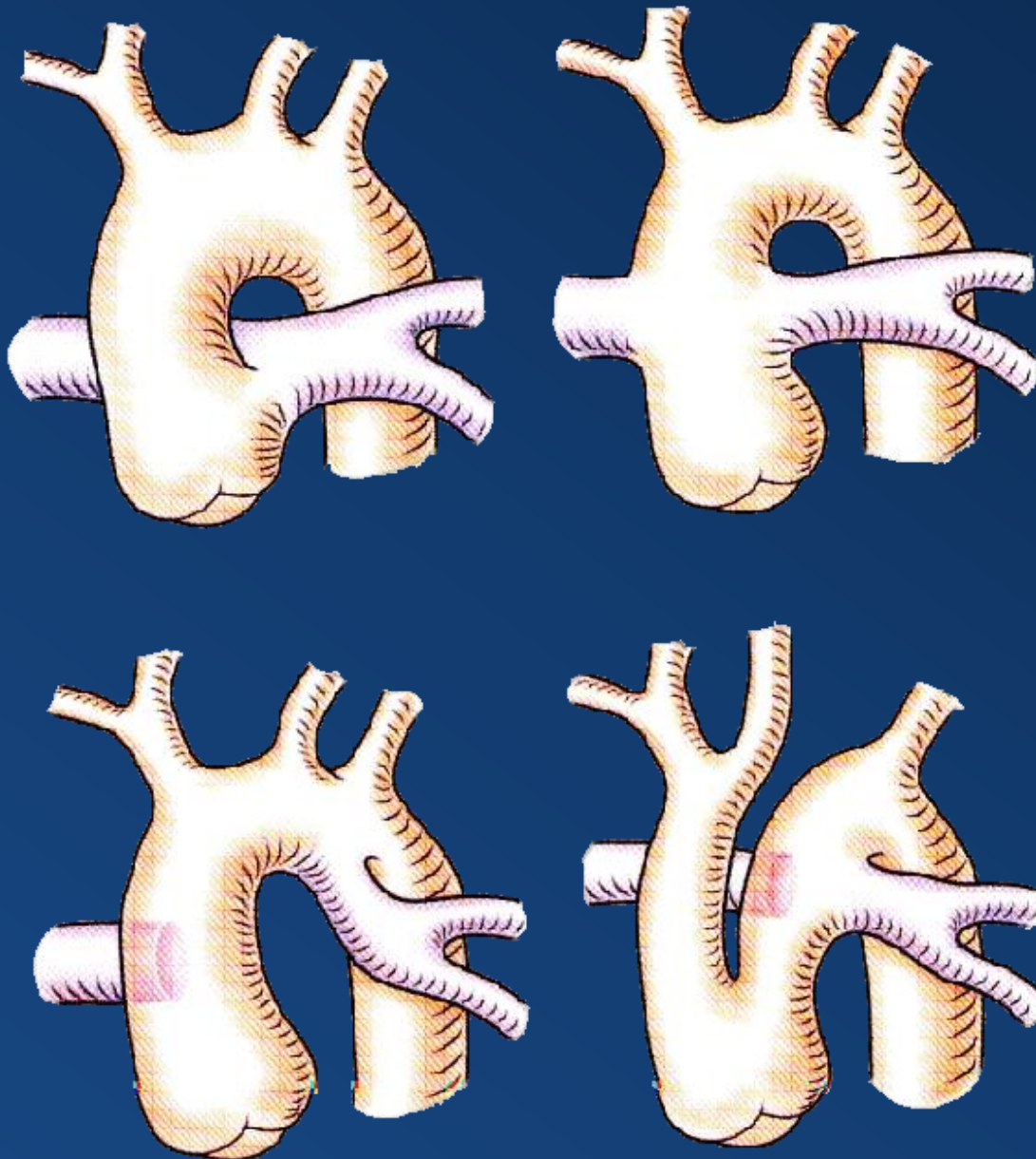
Pulmonary atresia: hybrid procedure



Pulmonary atresia: hybrid procedure

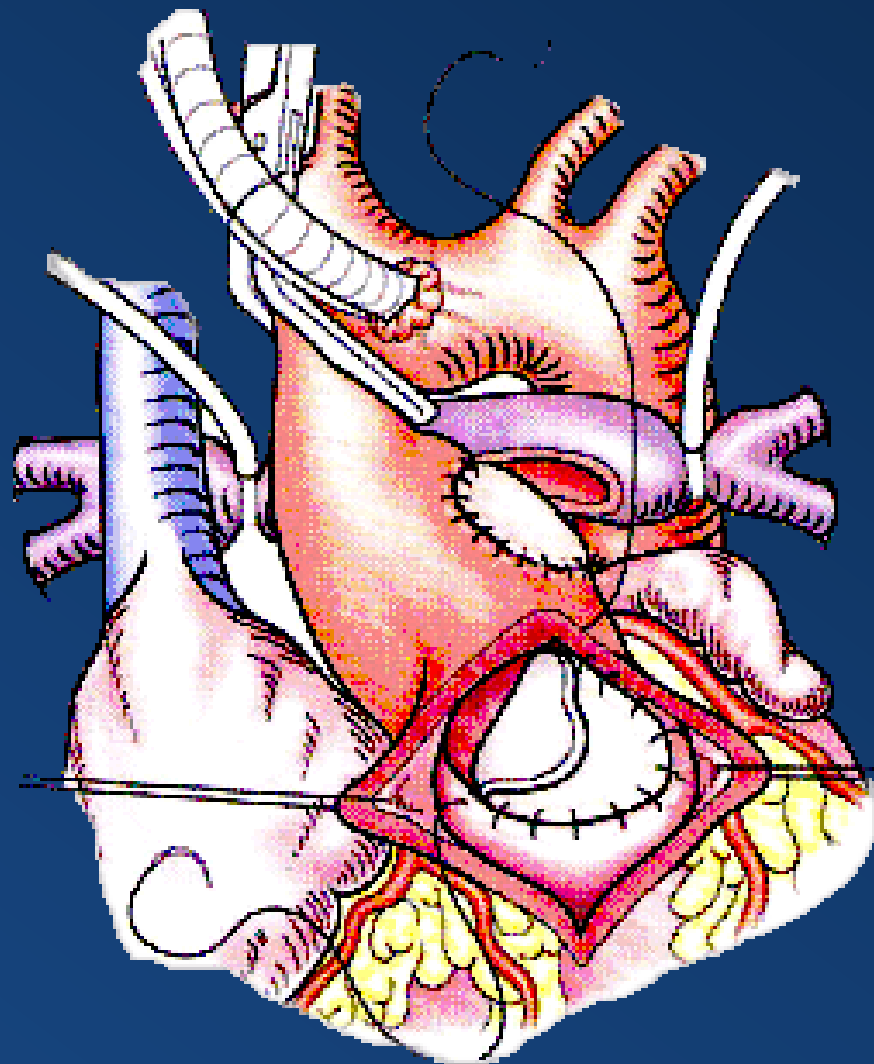


Truncus arteriosus

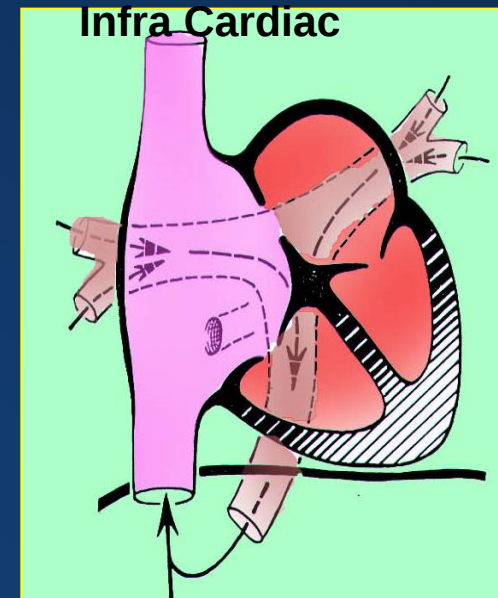
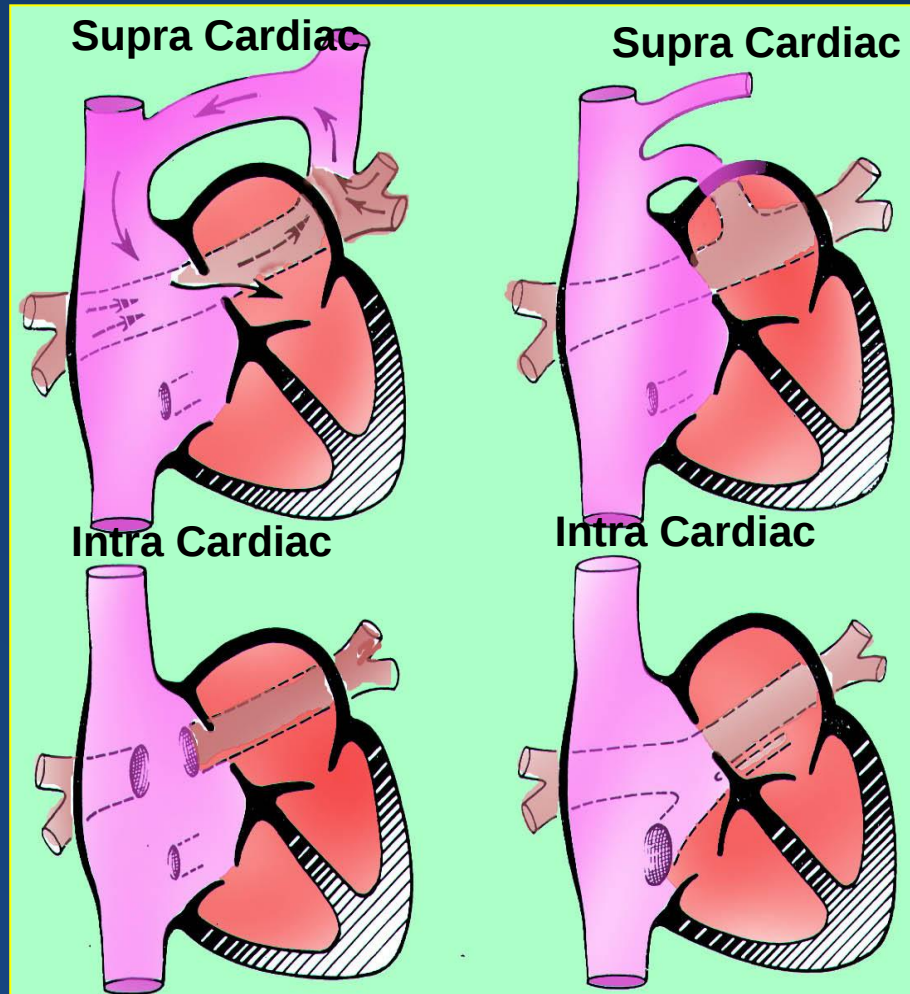


Truncus Arteriosus

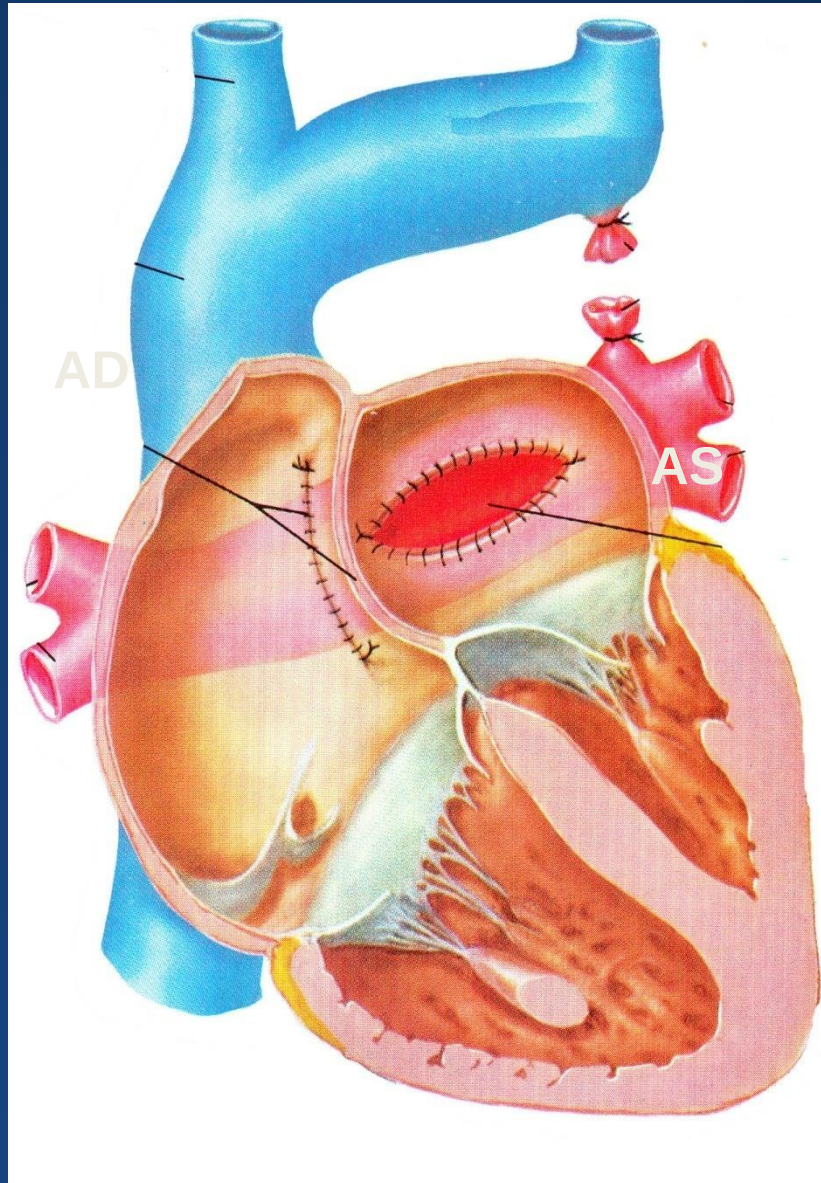
Surgical Correction



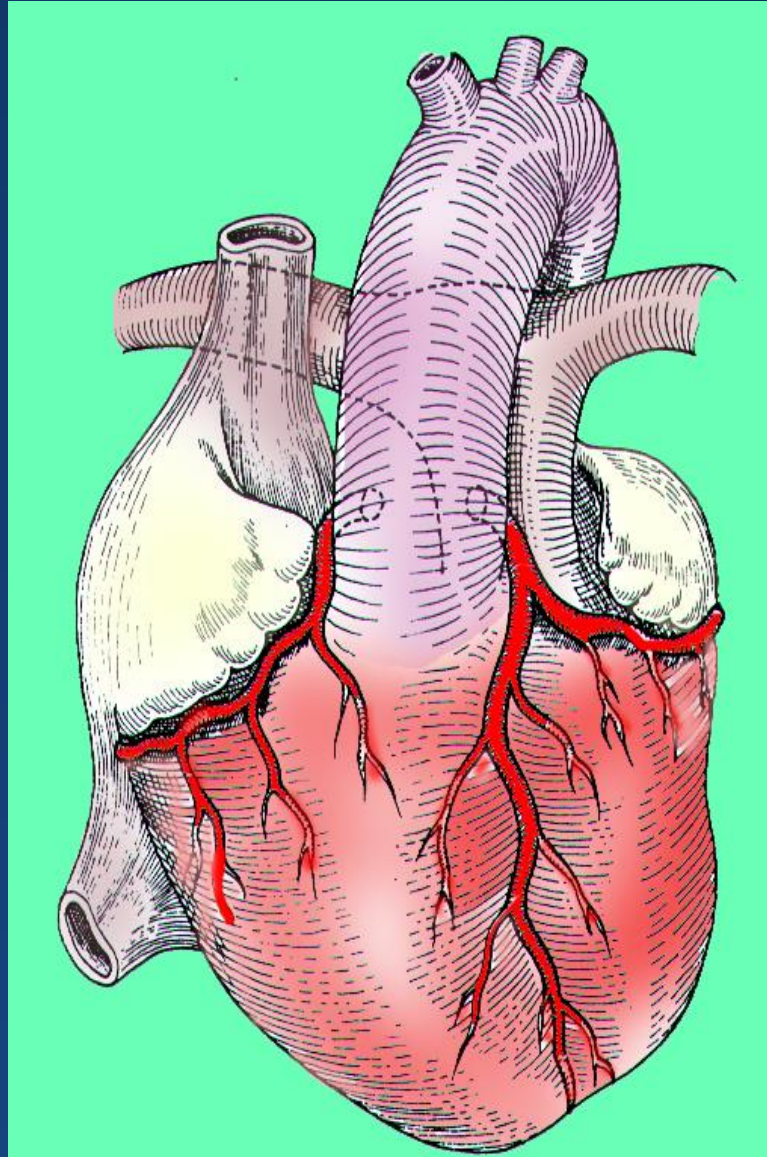
Total Anomalous Pulmonary Venous Connection TAPVC



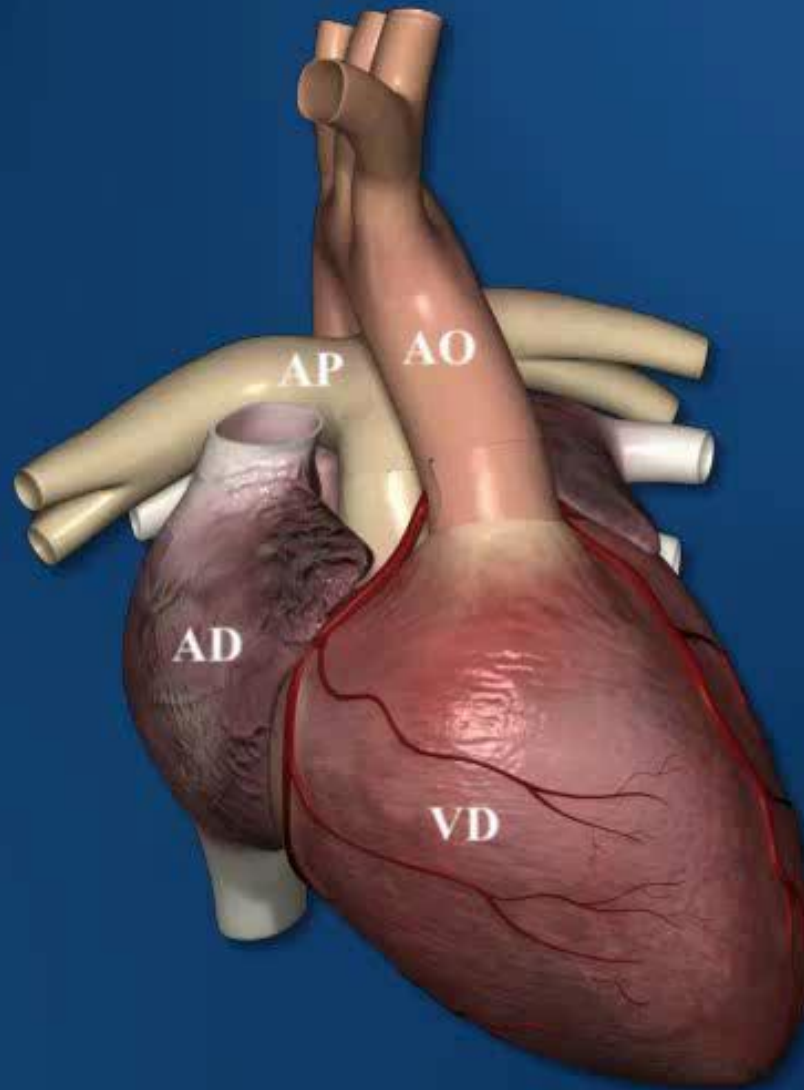
Total Anomalous Pulmonary Venous Connection Surgical Correction



TGA



TGA: switch operation



Birth defects

More than 7-9 million children are born, every year, with a serious congenital disorder.

The most common serious c. disorders are:

- ✓ **Congenital heart defects**
- ✓ **Neural tube defects**
- ✓ **Down syndrome**

Pediatric mortality

9.000.000 children die every year

3.500.000 die with the first 28 days of life

World health statistics 2008

Pediatric mortality

260.000 neonatal death are caused by
congenital anomalies

> 130.000 are due to heart diseases

World health statistics 2008

Mortality in neonatal cardiac surgery

Year	Mortality (%)	
1970	50-60	
1980	40	
1990	30	
2000	15	
2010	10 (ESCTS)	7.8(STS)

Surgical treatment in neonatal congenital heart disease.

Bove E. L. et al, Arch Dis Child. 1983
(Mortality 57%)

Pediatric cardiac mortality

Relationship between patient volume and outcome

Both annual surgeon volume and annual hospital volume are inversely correlated to mortality rate

Jen Kins KJ et al, PEDIATRICS 1995; 95 (3)

Hannan EL et al, PEDIATRICS 1998; 101 (6)

Pediatric cardiac mortality

Center volume/ mortality rate

Large volume centers

≥ 350 cases per year

For complex cases

Mortality %

8.4

Low volume centers

< 350 cases per year

For complex cases

Mortality %

14.8%

Welke et al, ANN THORAC SURG 2010:89

STS CONGENITAL HEART SURGERY DATA SUMMARY

JANUARY 2006 - DECEMBER 2009 PROCEDURES

NEONATES (0 - 30 DAYS) PTS 27,351

Year	Operations Submitted	Discharge Mortality	
		# / Eligible	% of patients
2006	6,346	361 / 3,228	11.2%
2007	6,832	383 / 3,420	11.2%
2008	7,581	377 / 3,734	10.1%
2009	6,592	327 / 3,298	9.9%
Total	27,351	1,448 / 13,680	10.6%

(EACTS DATA BASE)

Most Common Surgical Procedures

Procedure	n	Mortality %
ASO	2,154	5.99
CoA repair	2,012	4.63
PDA surgical closure	1,829	5.80
B-T shunt	1,501	12.0
Norwood procedure	1,216	36.2
ASO + VSD	657	9.55
TAPVC repair	426	16.5
IAA repair	283	19.2

ASO = arterial switch operation; B-T = Blalock-Taussig; CoA = coarctation of the aorta; IAA = interrupted aortic arch; PDA = patent ductus arteriosus; TAPVC = Total anomalous pulmonary vein connection; VSD = ventricular septal defect.

Progress in neonatal Cardiac Surgery

Pre-natal Diagnosis

Post-natal Diagnosis

Surgical Techniques

Extracorporeal Circulation

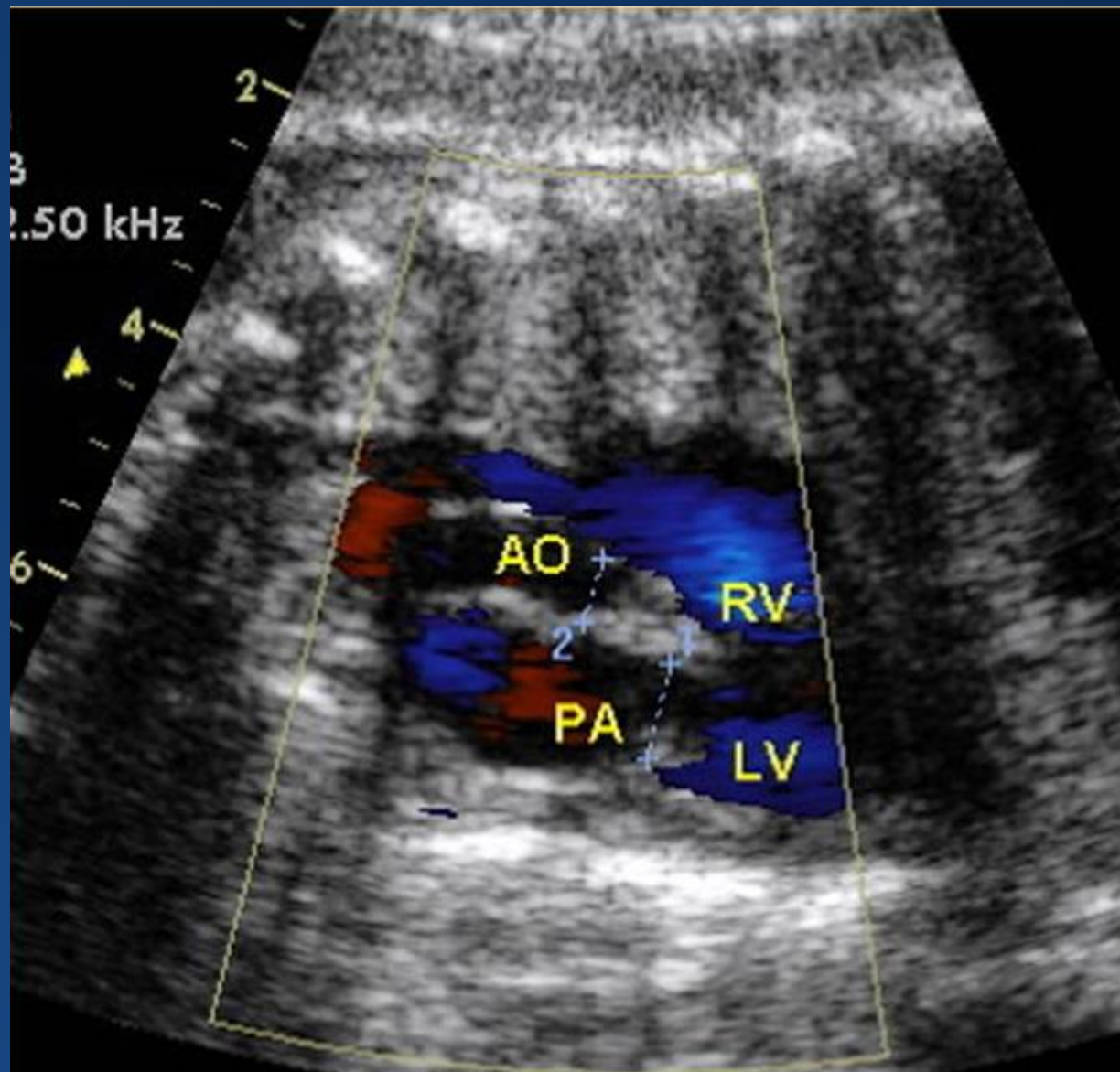
Perioperative management

Postoperative management

Preoperative advances

- Fetal diagnosis
- Ventilatory manipulation of pulmonary vasc. Res?
- Percutaneous interventional procedures
- Diagnostic tools (MMR Tangio)

Fetal Echo: TGA



PHILIPS

27/07/2010

13:40:41

TIS0.1 MI 0.3

X7-2/Pediatria

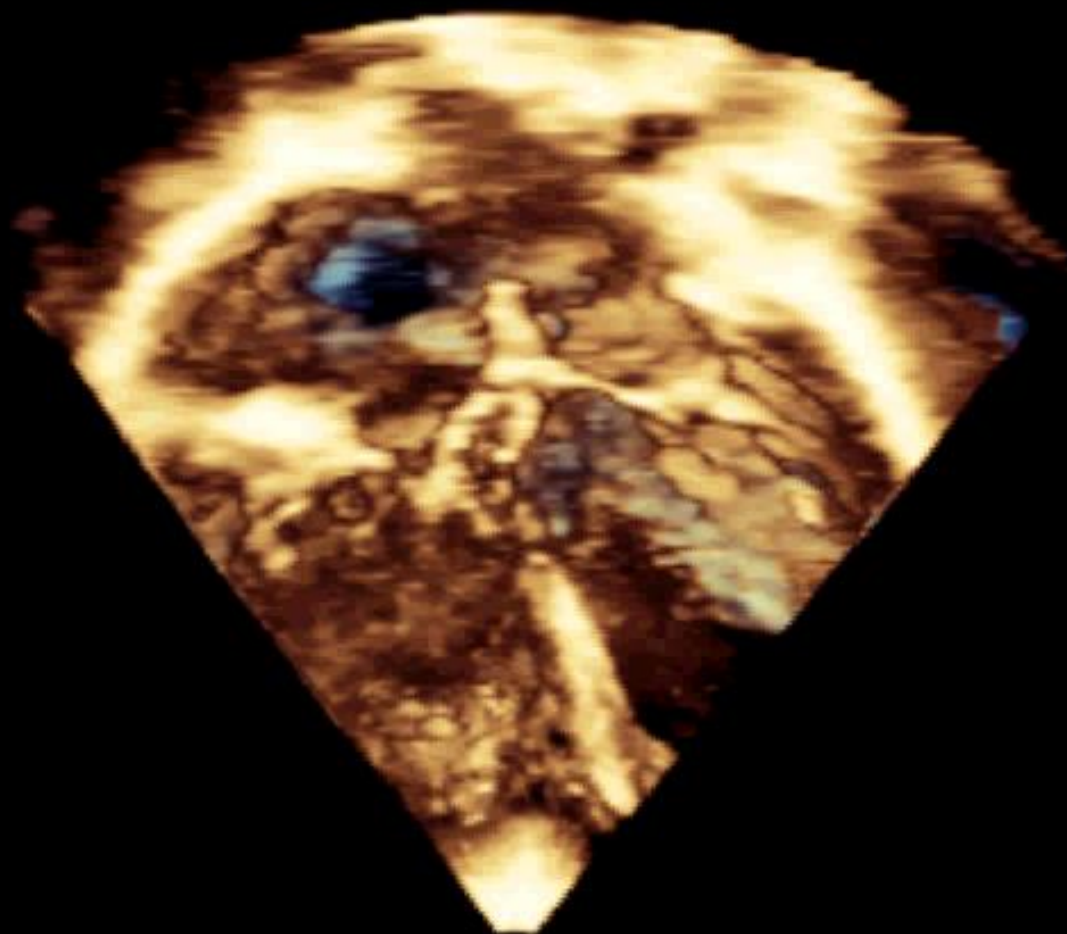
FR 27Hz
10cm

Volume completo

3D 27%

3D 13dB

M3



JPEG

98 bpm

Ritardo 0ms

PHILIPS

08/06/2010

16:42:46

TIS0.0 MI 0.3

X7-2/Pediatria

FR 32Hz

8.1cm

Volume completo

3D 25%

3D 50dB

M3

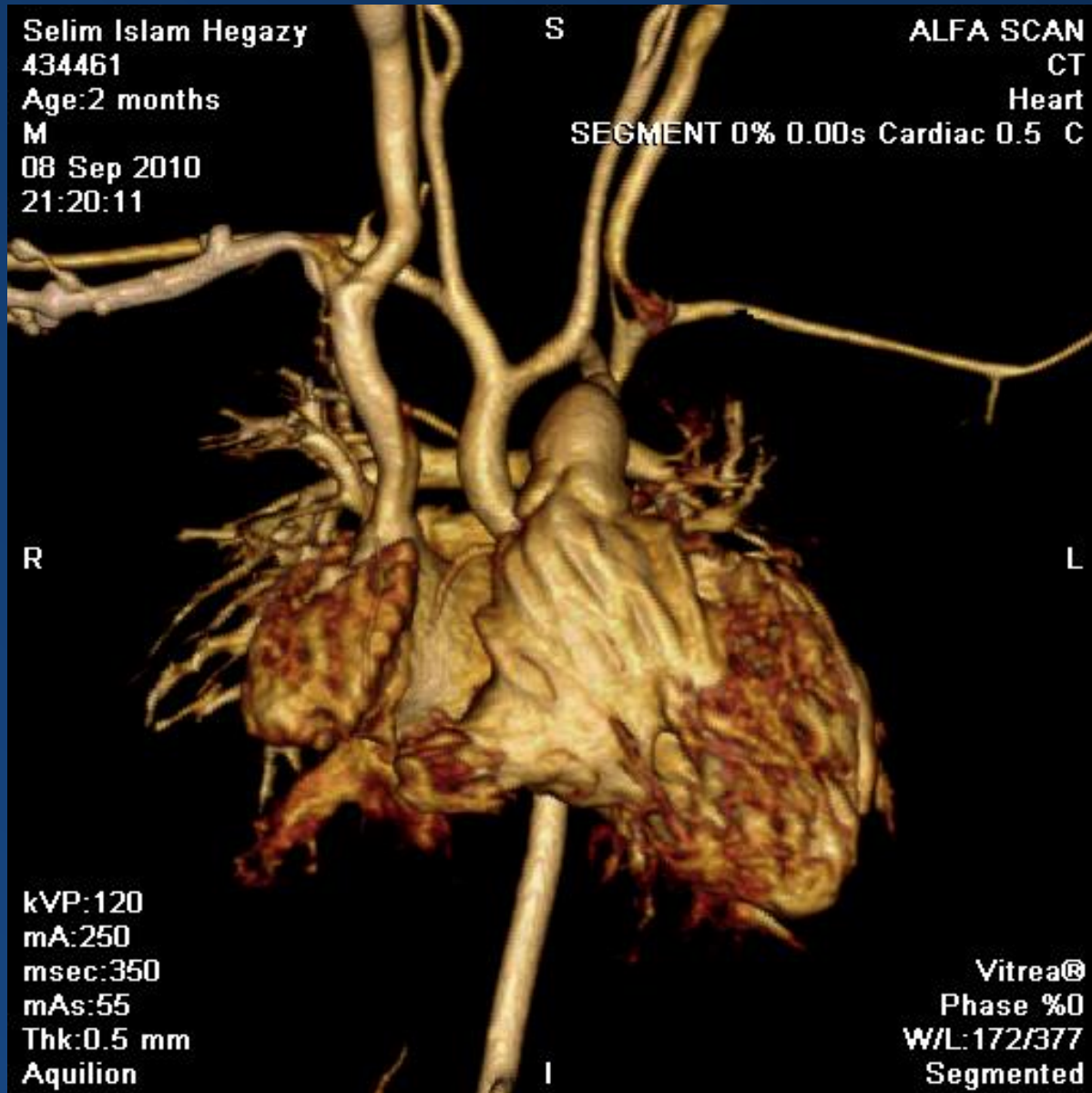


JPEG

181 bpm

PHILIPS Ritardo 0ms

CT angiography



Intraoperative advances

- Attenuation of inflammatory response
- Myocardial protection
- Ph management
- Circulatory arrest versus low-flow bypass
- Hybrid procedures

Progress in cardiac surgery

ECC



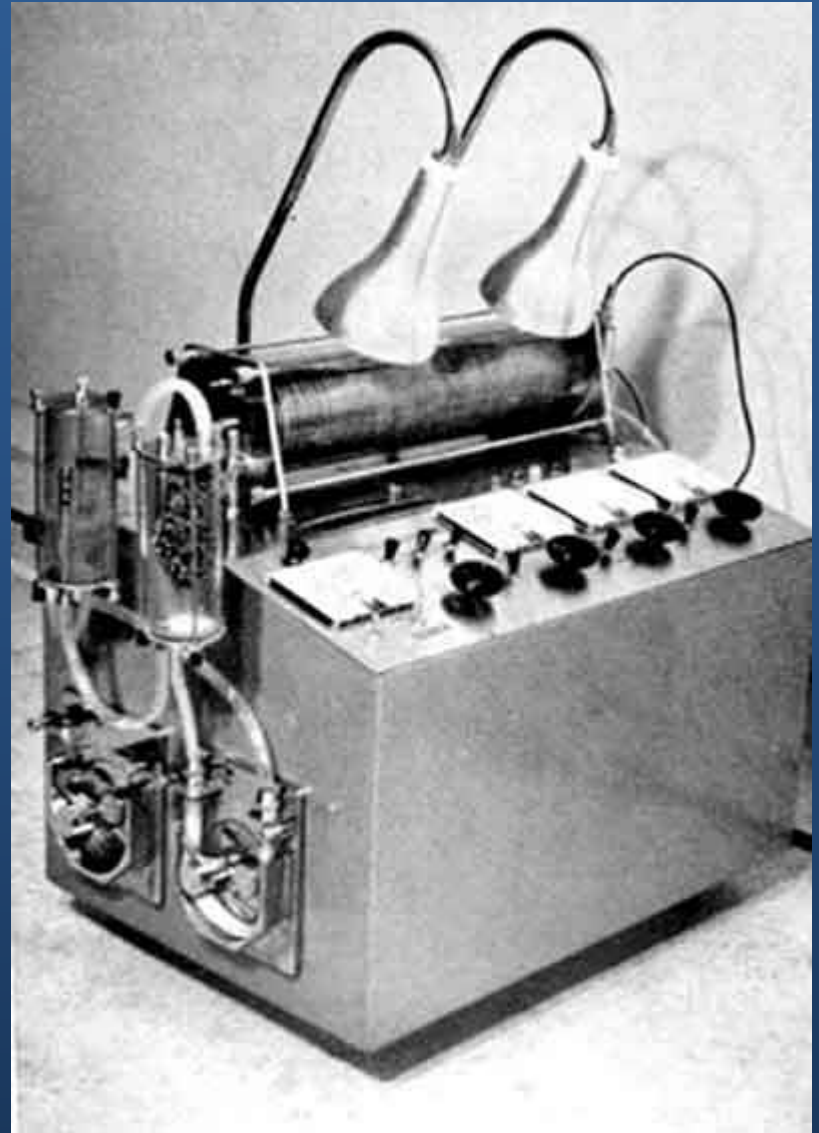
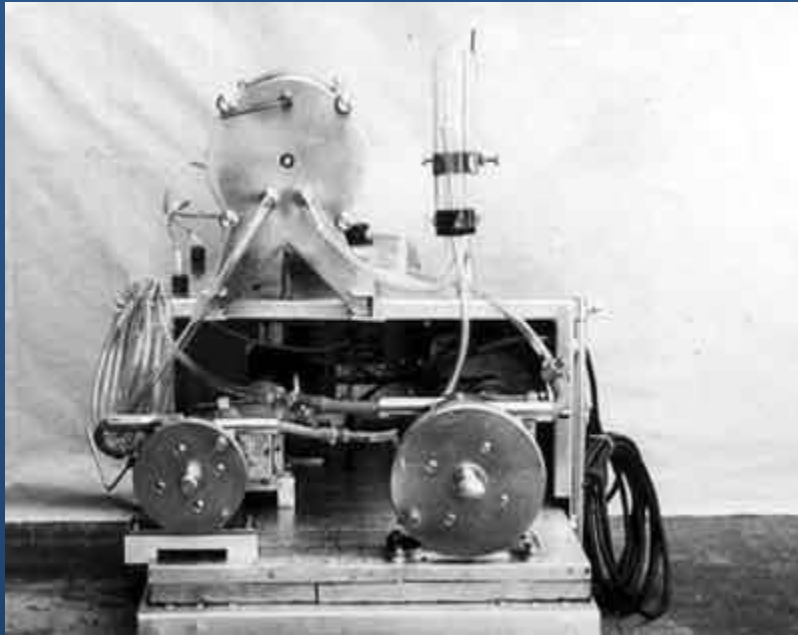
Circuit miniaturization

Control inflammatory responses

Hypothermic low flow

Cerebral blood flow control systems

FIRST MACHINE FOR EXTRACORPOREAL CIRCULATION



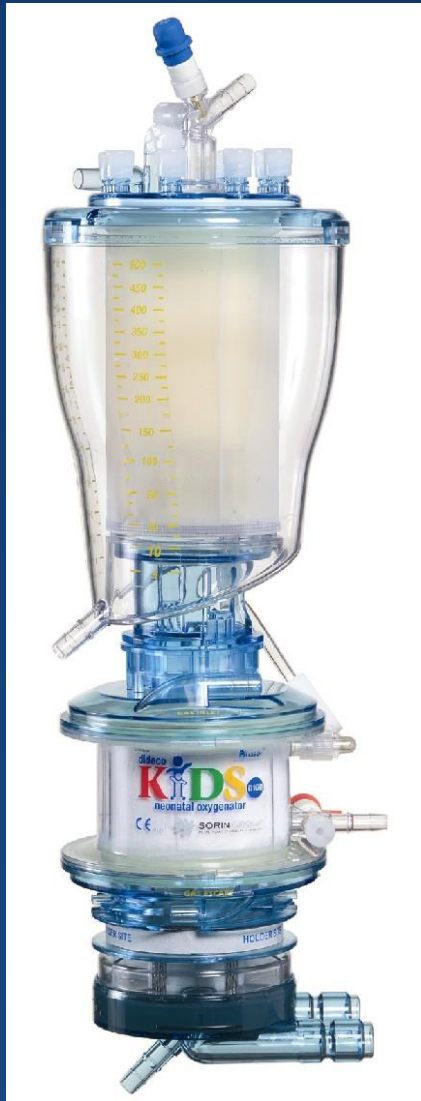
ABOUT OXYGENATION

SECOND GENERATION

LILLIPUT 2



KIDS NEONATAL FAMILY



D100 KIDS Neonatal oxygenator is the
WORLD'S SMALLEST OXYGENATOR

D130 KIDS Neonatal Arterial Filter is the
WORLD'S SMALLEST ARTERIAL FILTER



Dideco **KIDS** is the
FIRST and **ONLY**

CPB SYSTEM

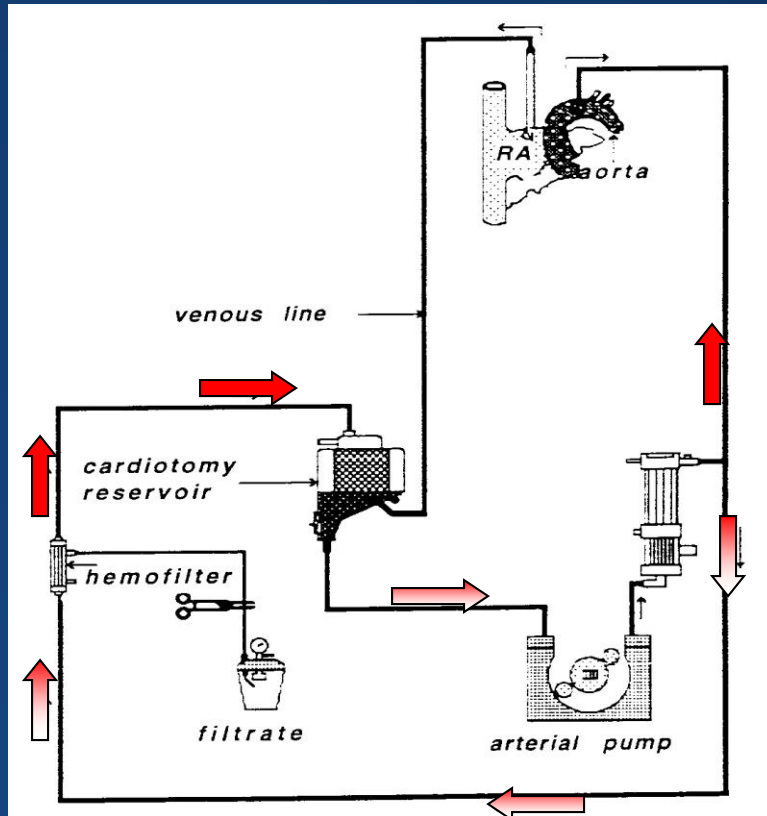
EXCLUSIVELY DEDICATED to
NEONATAL PATIENTS

PRIME VOLUME DIFFERENCES

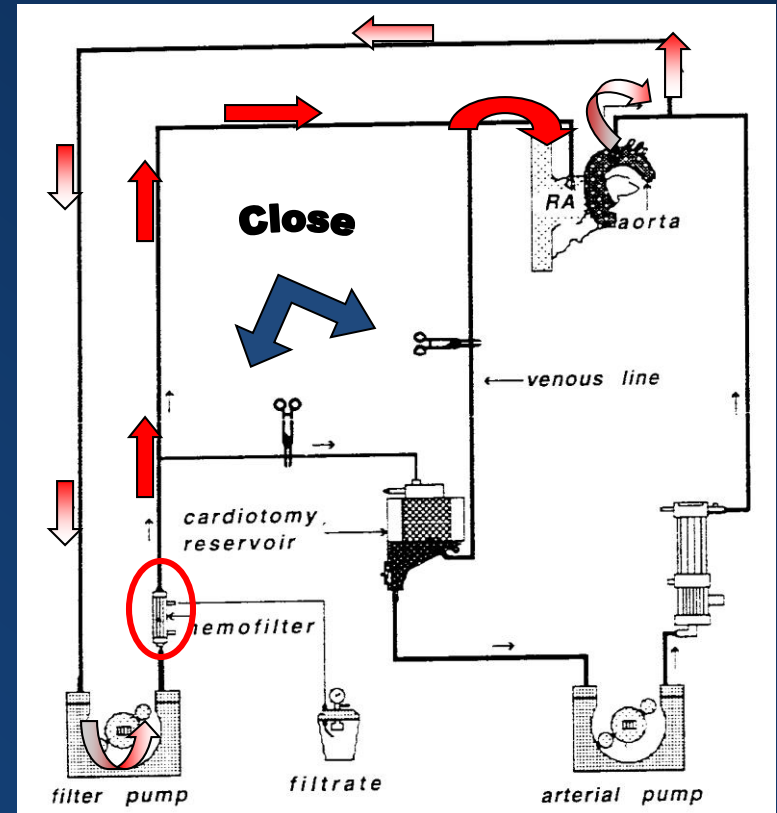
- LILLIPUT 1 ----- 203.4 ml
- LILLIPUT 2 ----- 380.8 ml
- KIDS D100 ----- 167.4 ml

Ultrafiltration

CLASSIC

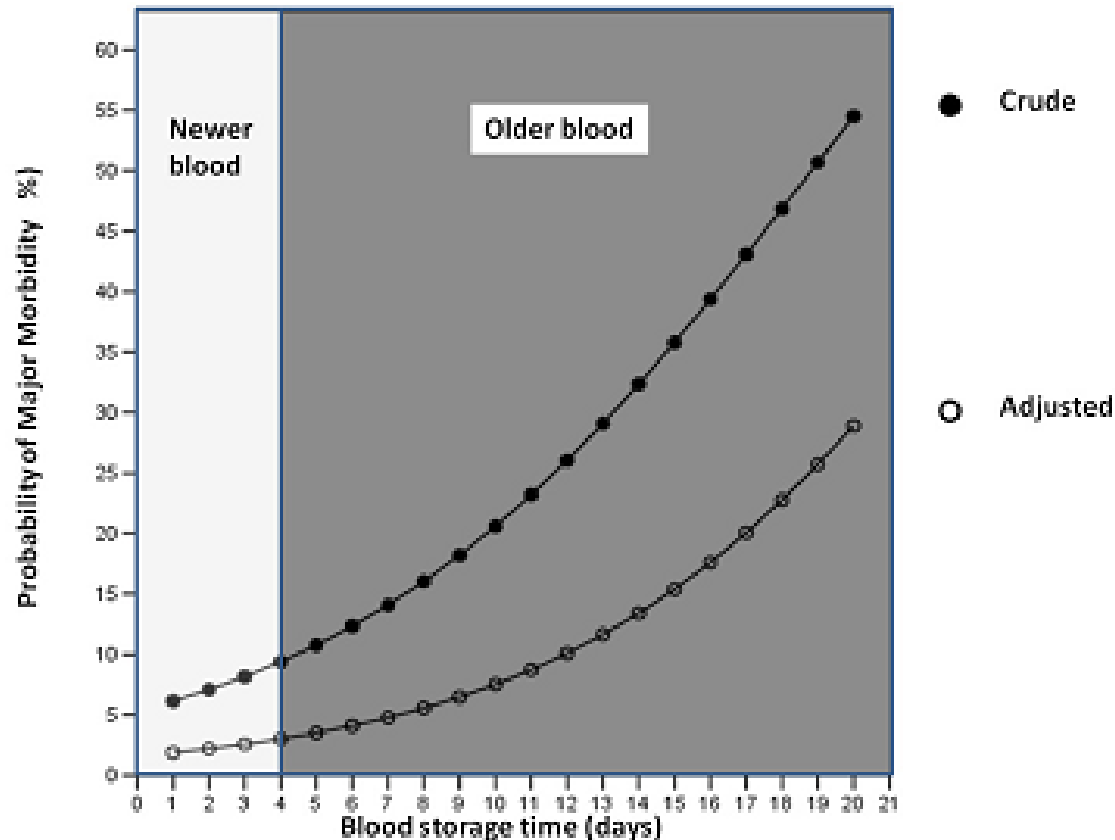


MODIFIED



Perioperative management

Figure 2



Crude and adjusted likelihood of experiencing major morbidity in the group receiving blood prime.

Perioperative management

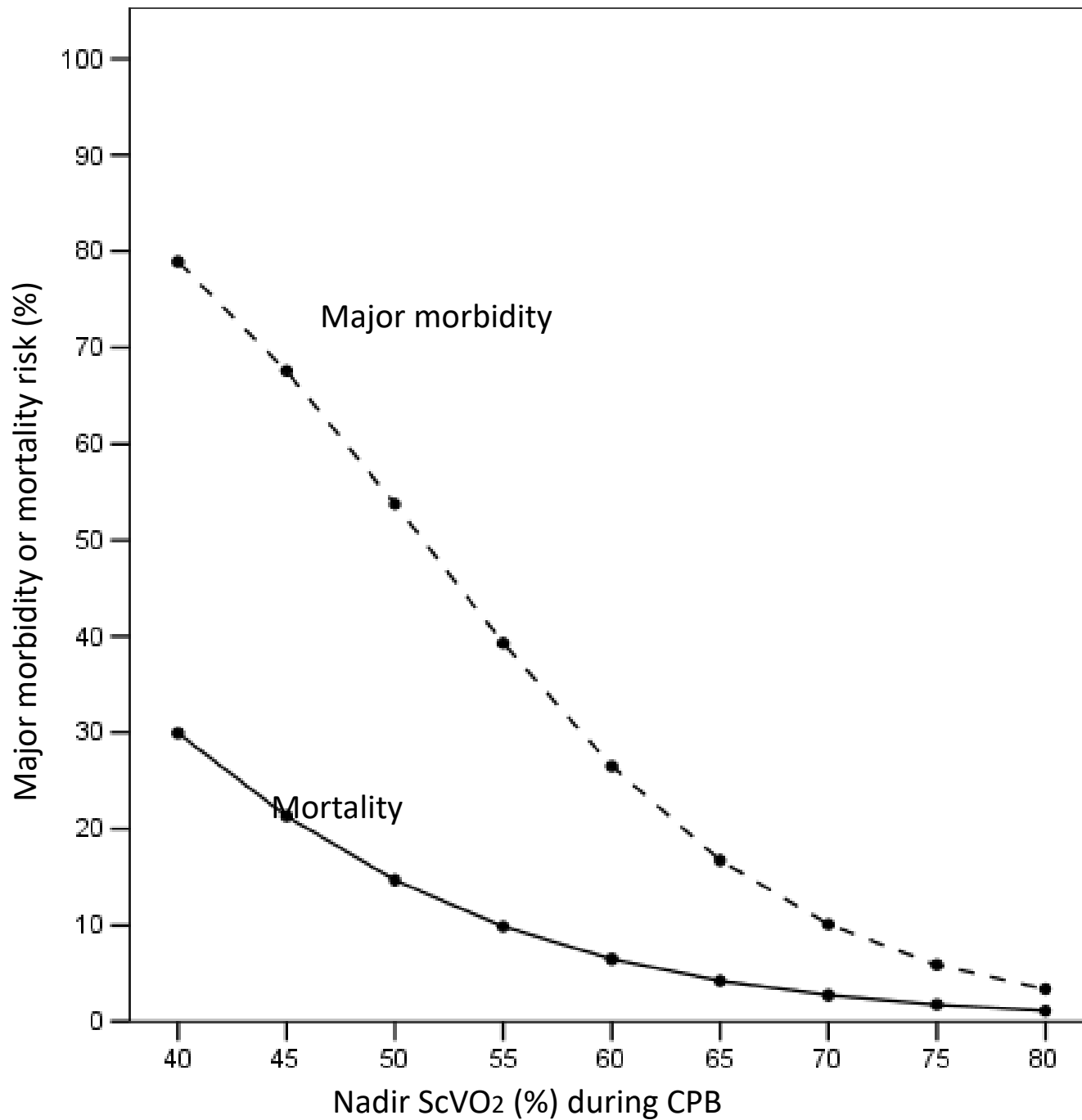


Figure 2

Perioperative management

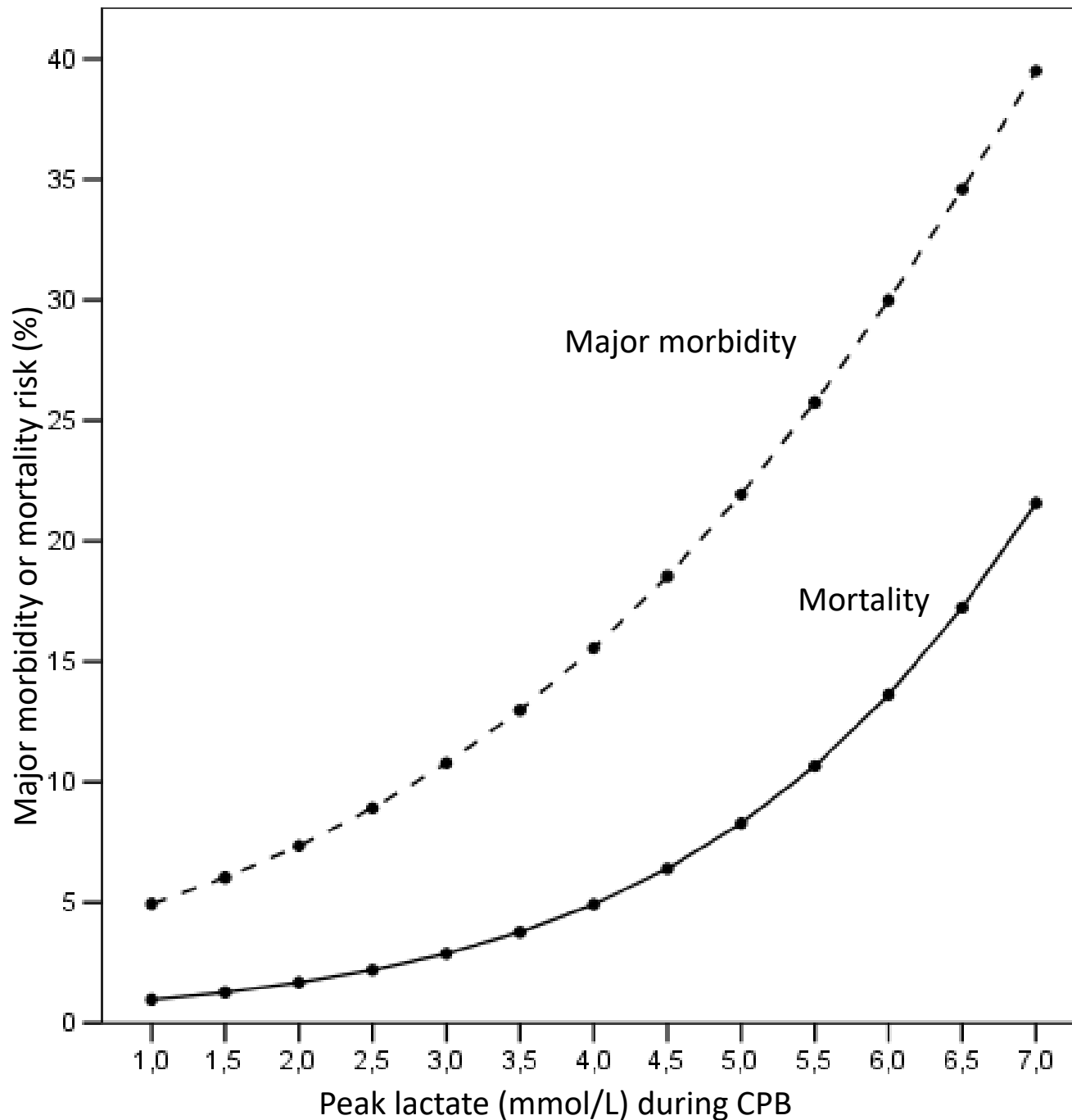


Figure 3

Progress in neonatal cardiac surgery

Post-operative management

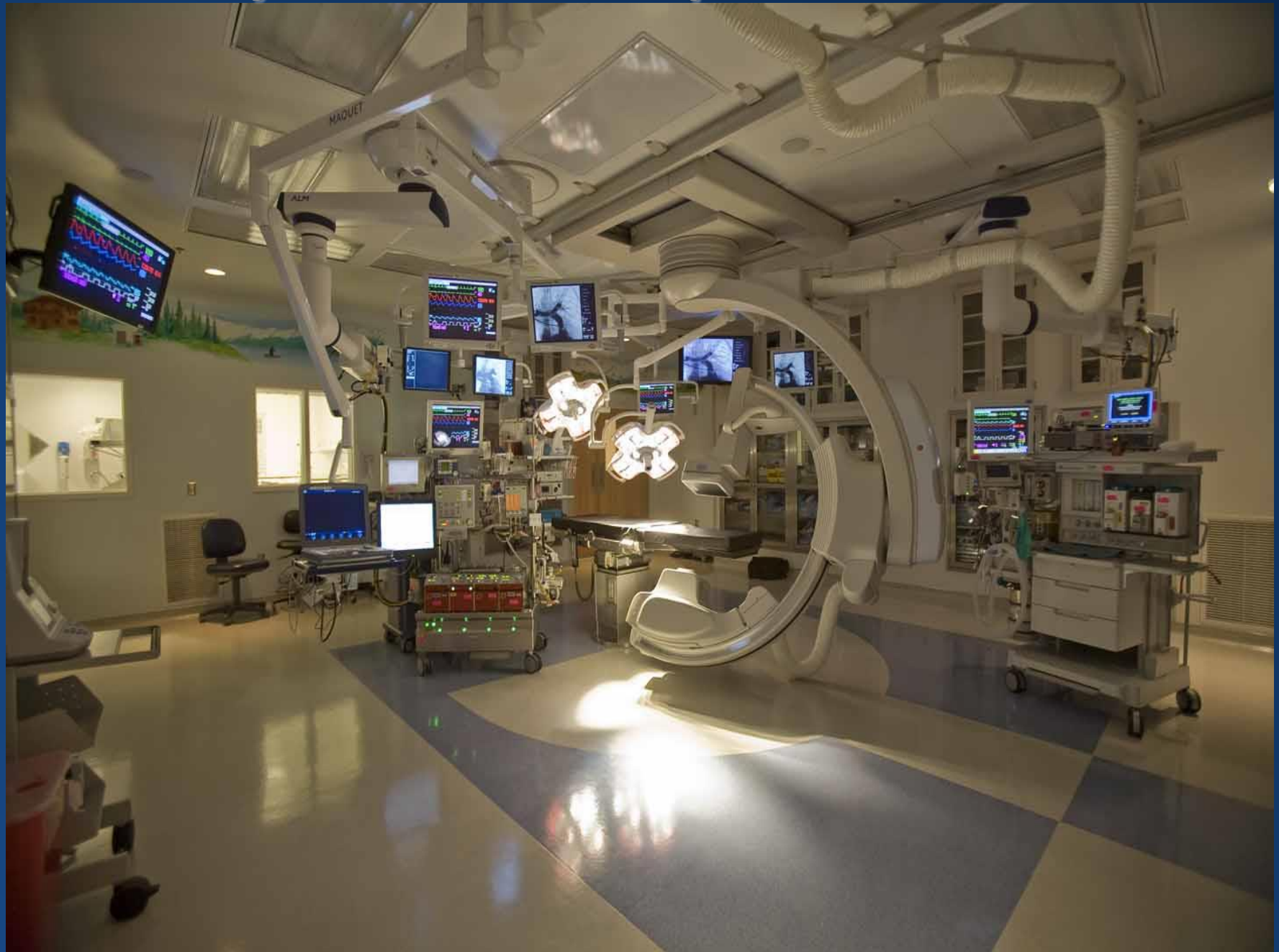


- ▶ Ventilatory techniques customized
- ▶ Nitric oxide
- ▶ Circulatory support

Operating Room for Hybrid Procedures

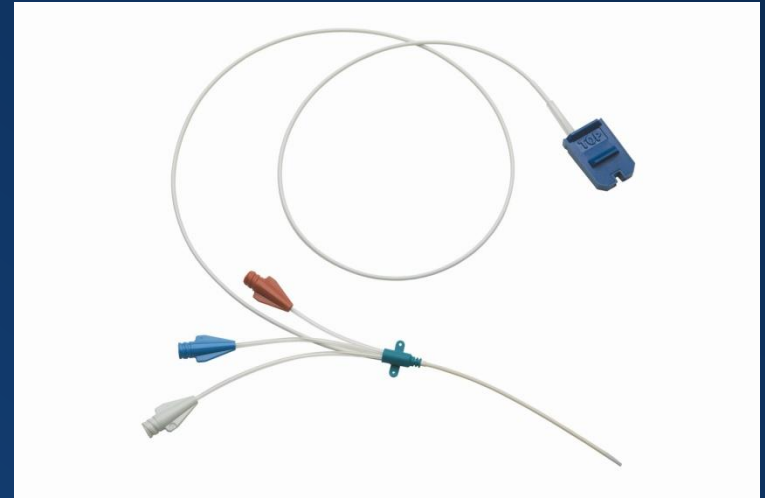


Hybrid Cardiac Operative Suite



What is PediaSat?

- Continuous ScvO₂ monitoring
- Pediatric sized
- Multiple Lumens



Model	5cm	8cm	15cm
4.5F	X	X	
5.5F		X	X

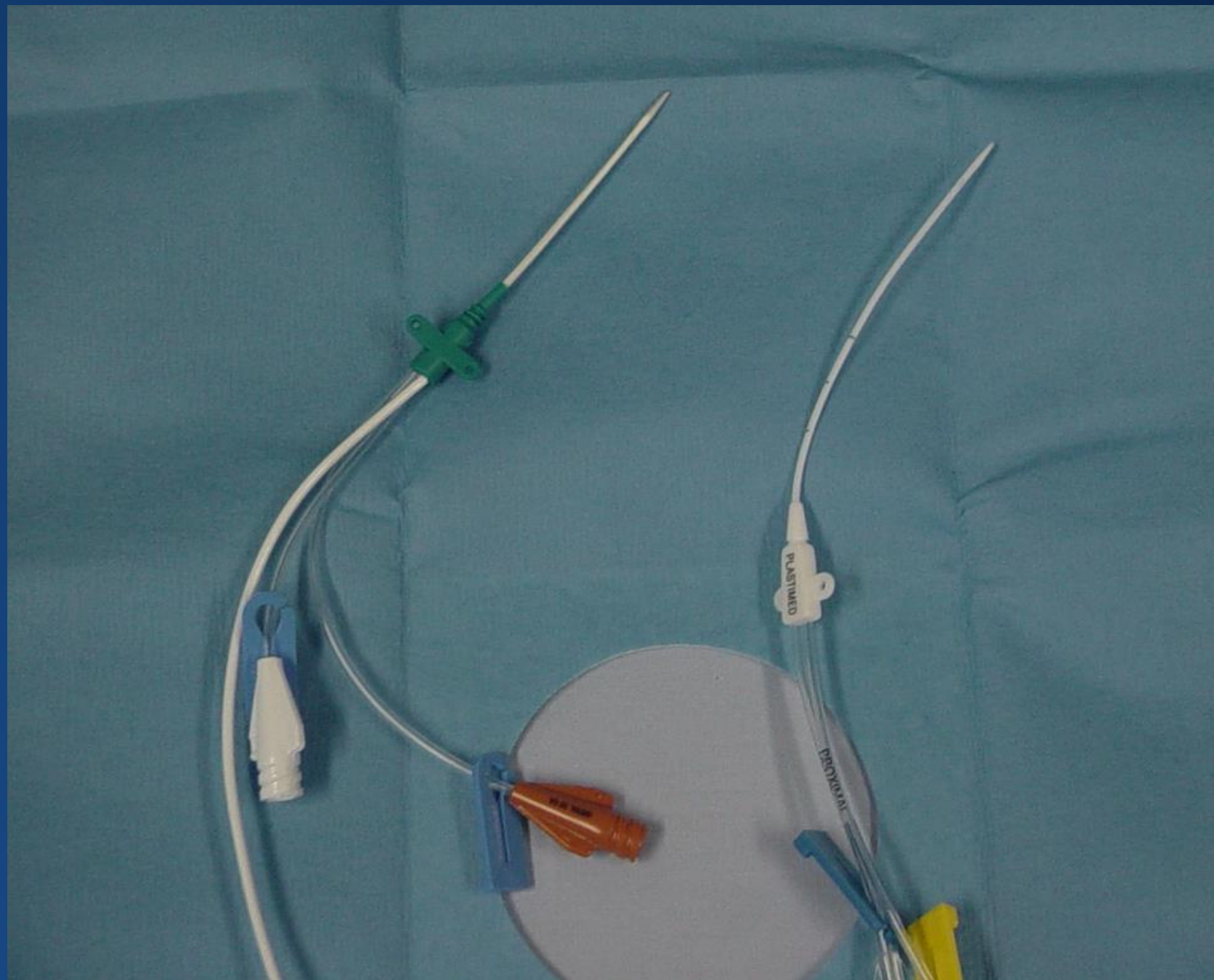
Assumptions:

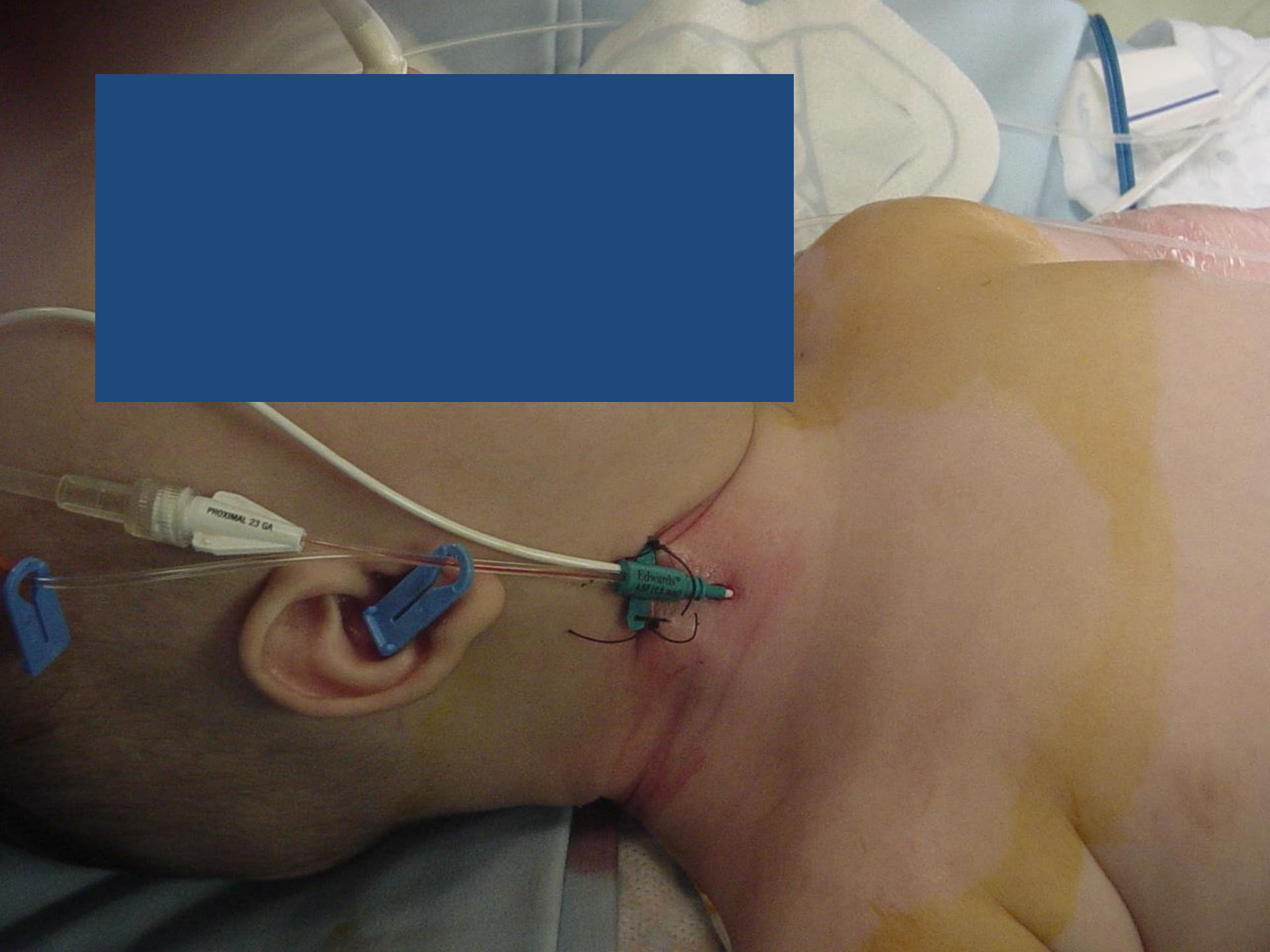
4.5 F: birth - 36 months

5.5F: >36 months

Peds <3 mos: 5 cm

Peds >3 mos: 8cm, 15 cm

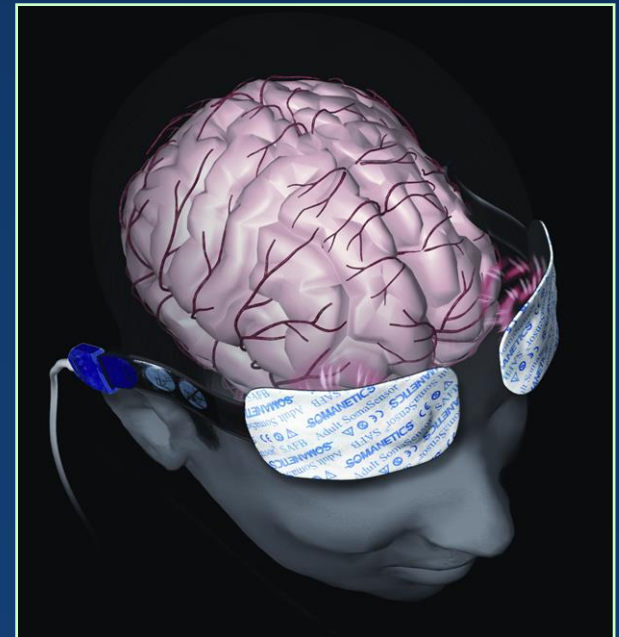




Noninvasive Monitoring

Methodologies for Noninvasive Assessment

- Cerebral Near-Infrared Spectroscopy (NIRS)





THE HEMOSTASYS – COAGULATION BEDSIDE LABORATORY

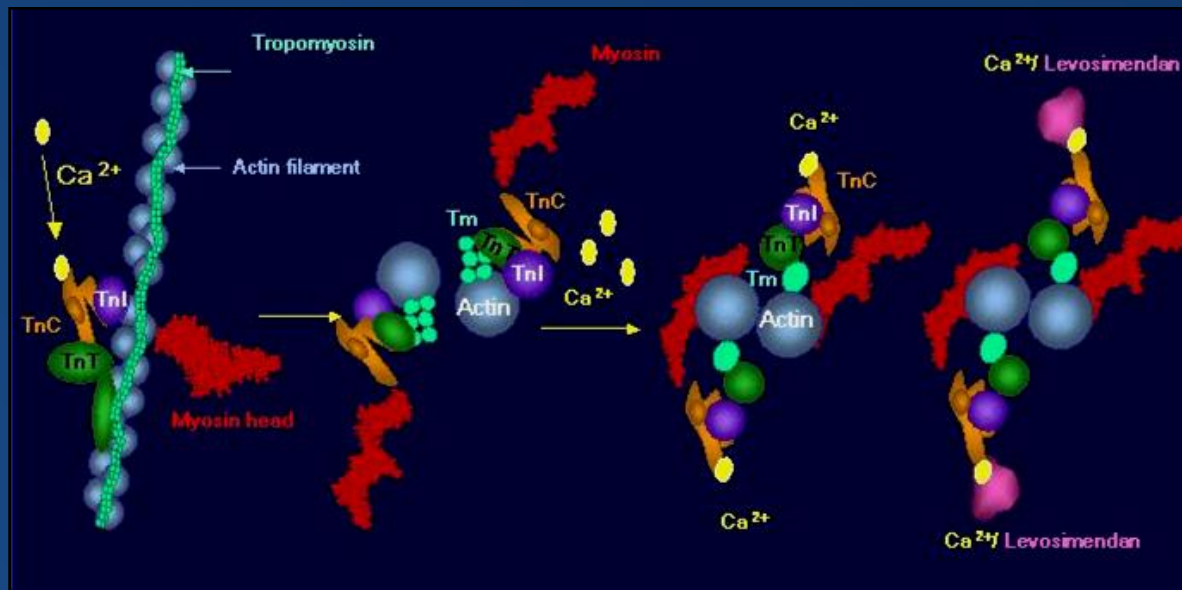
San Donato Pediatric Intensive Care



New Medical Strategies

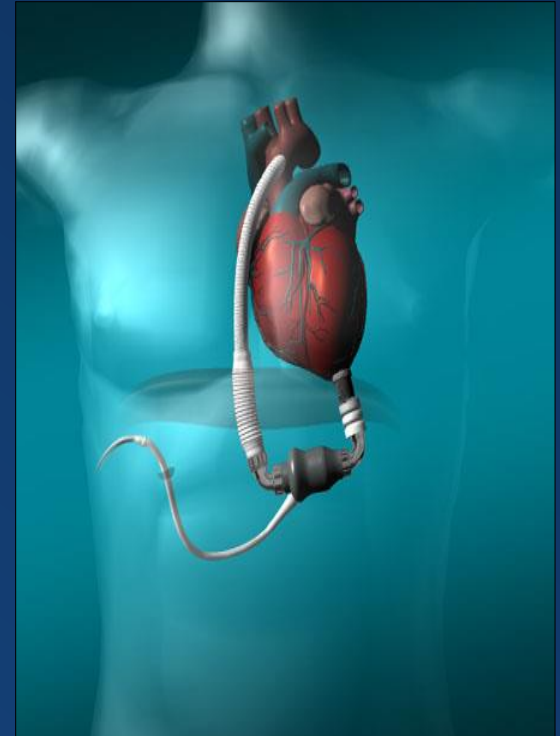
● Calcium Sensitizers (Levosimendan)

- Enhancement of contractility by binding to troponin C and increasing myofilament sensitivity to calcium
- Vasodilation via K^+ -dependent ATP channels and inhibition of PDE.



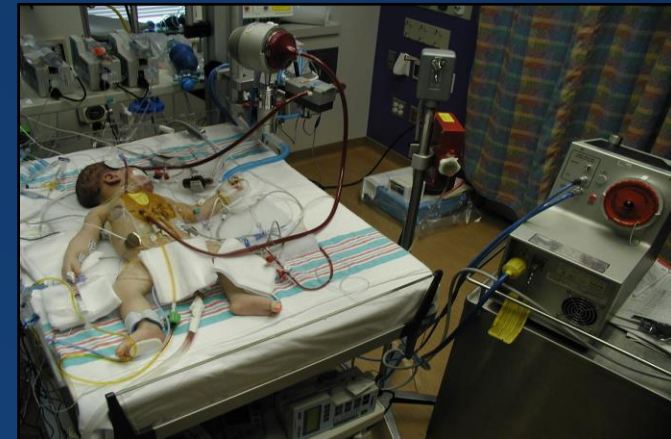
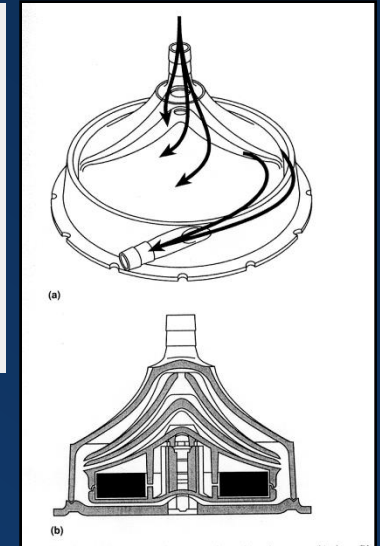
Ventricular Failure and Assist Device

- Acute
- Chronic



Ventricular Failure and Assist Device

- Short Term (Acute)
 - Ventricular Assist Device (VAD)
 - Centrifugal pump
 - Acrylic rotator cones
 - 50 and 80 mL volumes with up to 10 L of flow
 - Right or left or single ventricle support



Targeting Mixed Venous Saturation

- few studies have specifically targeted resuscitation to a mixed venous saturation of ≥70%
- prospective, randomized trial in adults:
treatment to a mixed venous saturation ≥70% did not reduce mortality compared with therapy targeting a normal CI

(Gattinoni et al. *NEJM* 1995)

Neonatal Dialysis Machine (new prototype)





CARPEDIEM

Cardio Renal Pediatric Dialysis Emergency Machine

Un progetto combinato di



Associazione Amici del Rene di Vicenza (ONLUS)

Associazione Bambini Cardiopatici nel Mondo (ONLUS)



CARDIO
RENAL
PEDIATRIC
DIALYSIS
EMERGENCY
MACHINE

S. CARLO VINCENZIUS
VICENZA

TOWARDS MINIATURIZATION



Operational Characteristics

	ADULT	NEONATE
Body Weight	75 Kg	3 Kg
Blood Volume	5.5 L	200 ml
Extracorporeal Circuit Priming	350 ml	15 ml
Blood Flow	300 ml/min	30 ml/min
Ultrafiltration range	3000 ml/24h	200 ml/24h
Accuracy	± 10 ml/min	±0.1 ml/min



NEONATAL MORTALITY - SAN DONATO

YEARS	NUMBER	MORTALITY	%
2000-2005	182	32	17 %
2006-2009	122	16	13 %
2010-2011	81	8	10 %

Conclusioni 1

La terapia chirurgica dei neonati con cardiopatie congenite complesse rappresenta la sfida più difficile e stimolante per il cardiocirurgo

La collaborazione con ostetrici, cardiologi pediatri e neonatologi migliora i risultati chirurgici in questi pazienti

Conclusioni 2

**La realizzazione di unità centralizzate,
dovrebbe essere l'obiettivo per
l'ottimizzazione delle risorse ed il
miglioramento dei risultati**