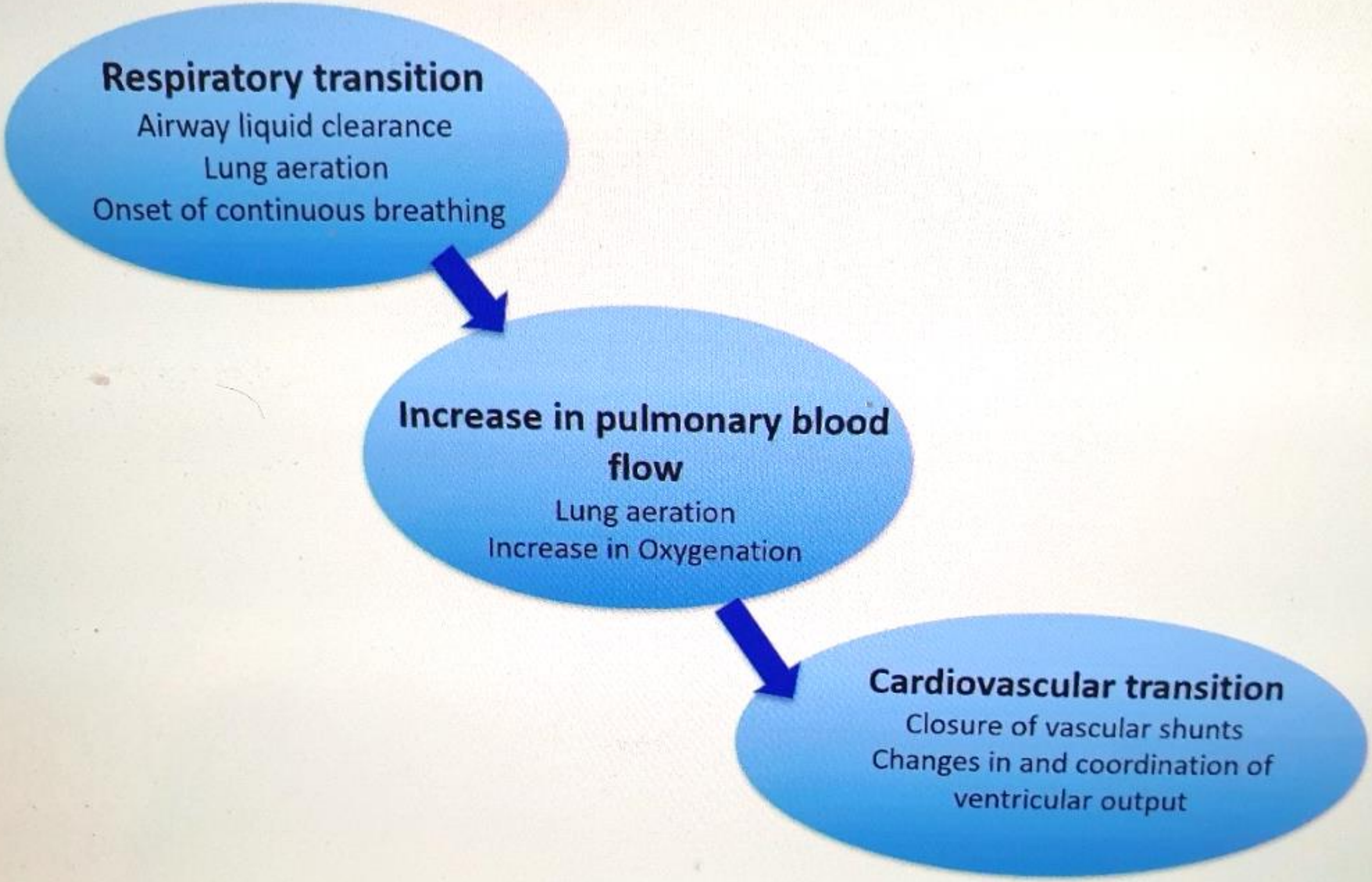
Quoi de neuf
CDH 2022, Glasgow
***

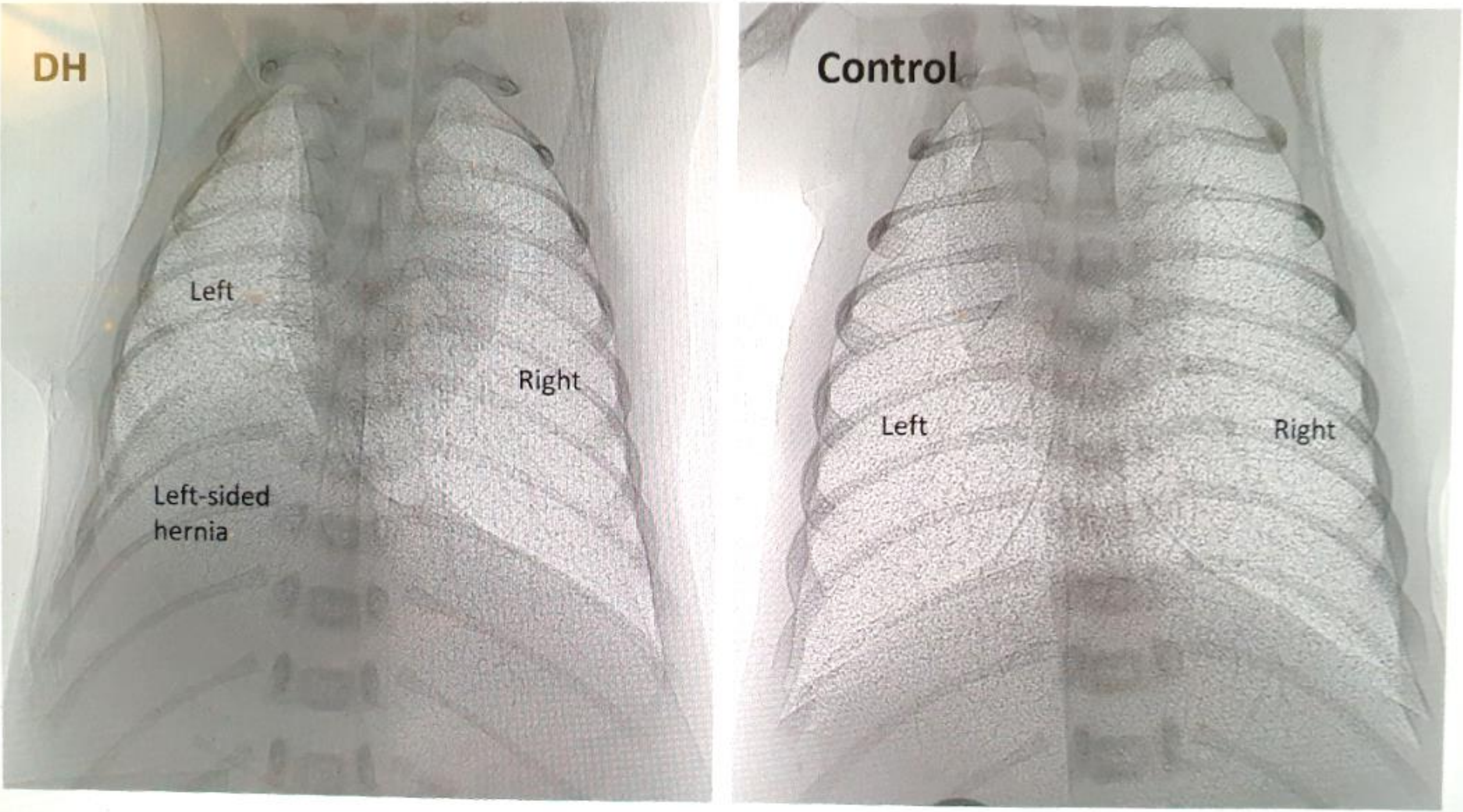
Réanimation néonatale

*

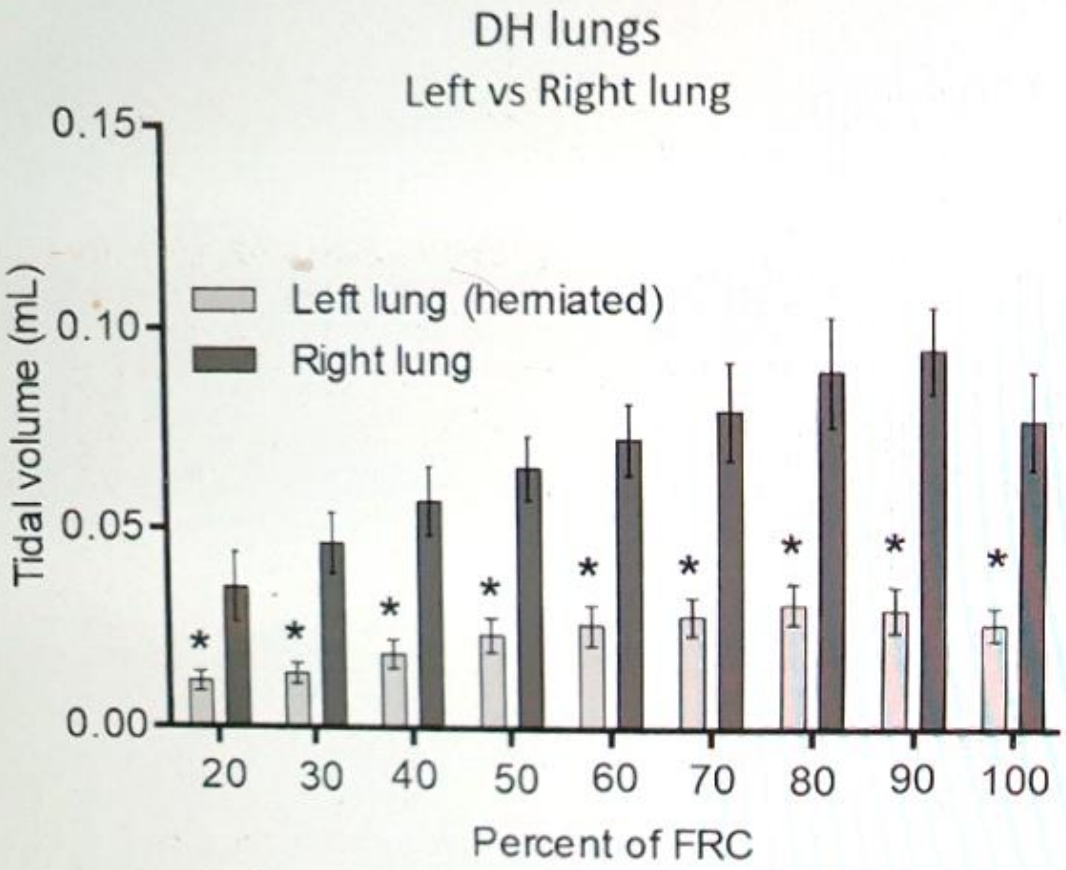
Fetal to Neonatal transition

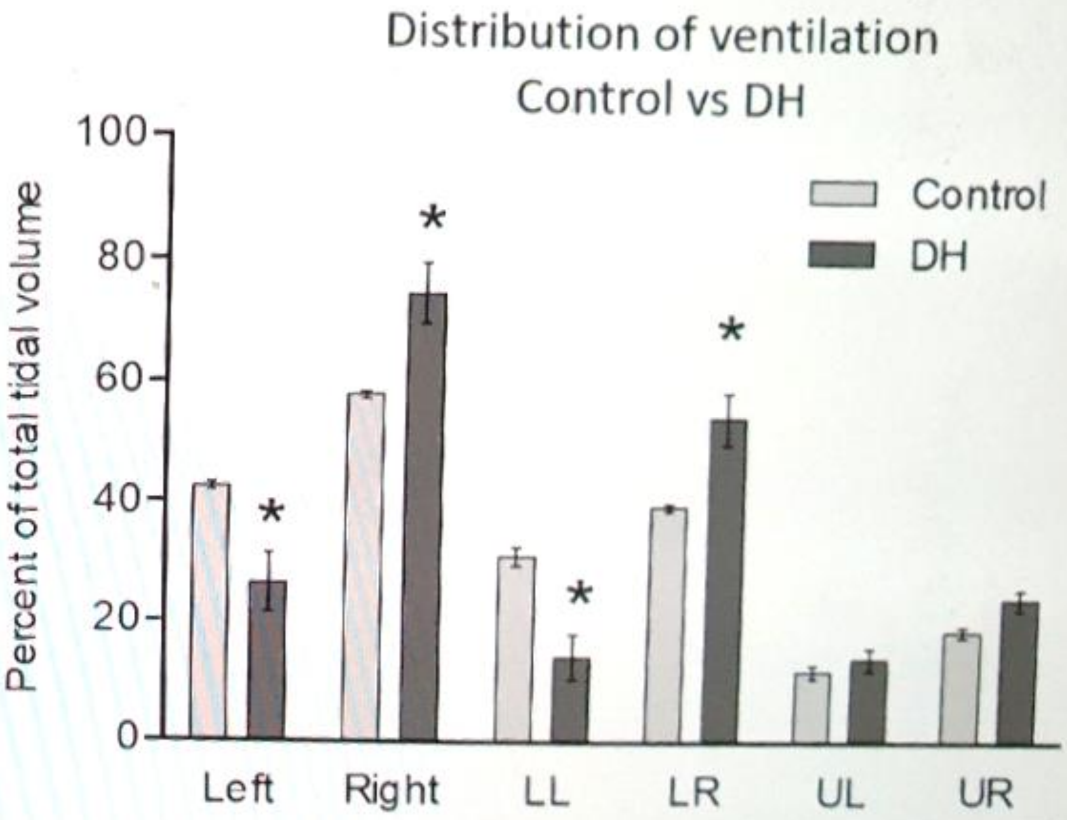


Phase contrast X-ray imaging

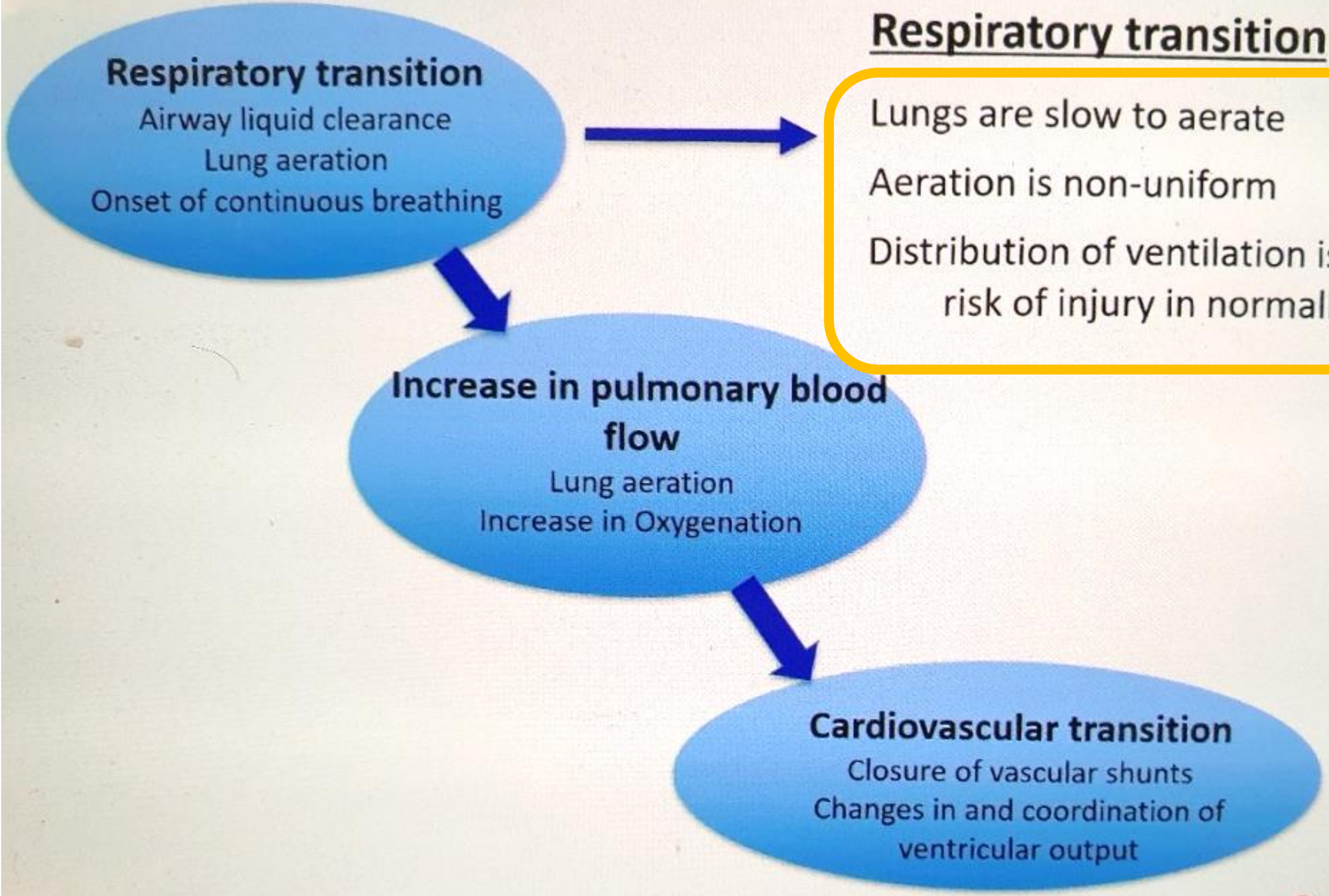


Distribution of ventilation





Fetal to Neonatal transition



Respiratory transition

Lungs are slow to aerate

Aeration is non-uniform

Distribution of ventilation is abnormal – risk of injury in normally grown regions

PPHN in CDH

High Resistance is due to:

✓ 1. Small lungs = reduced total cross-sectional area of arterial tree

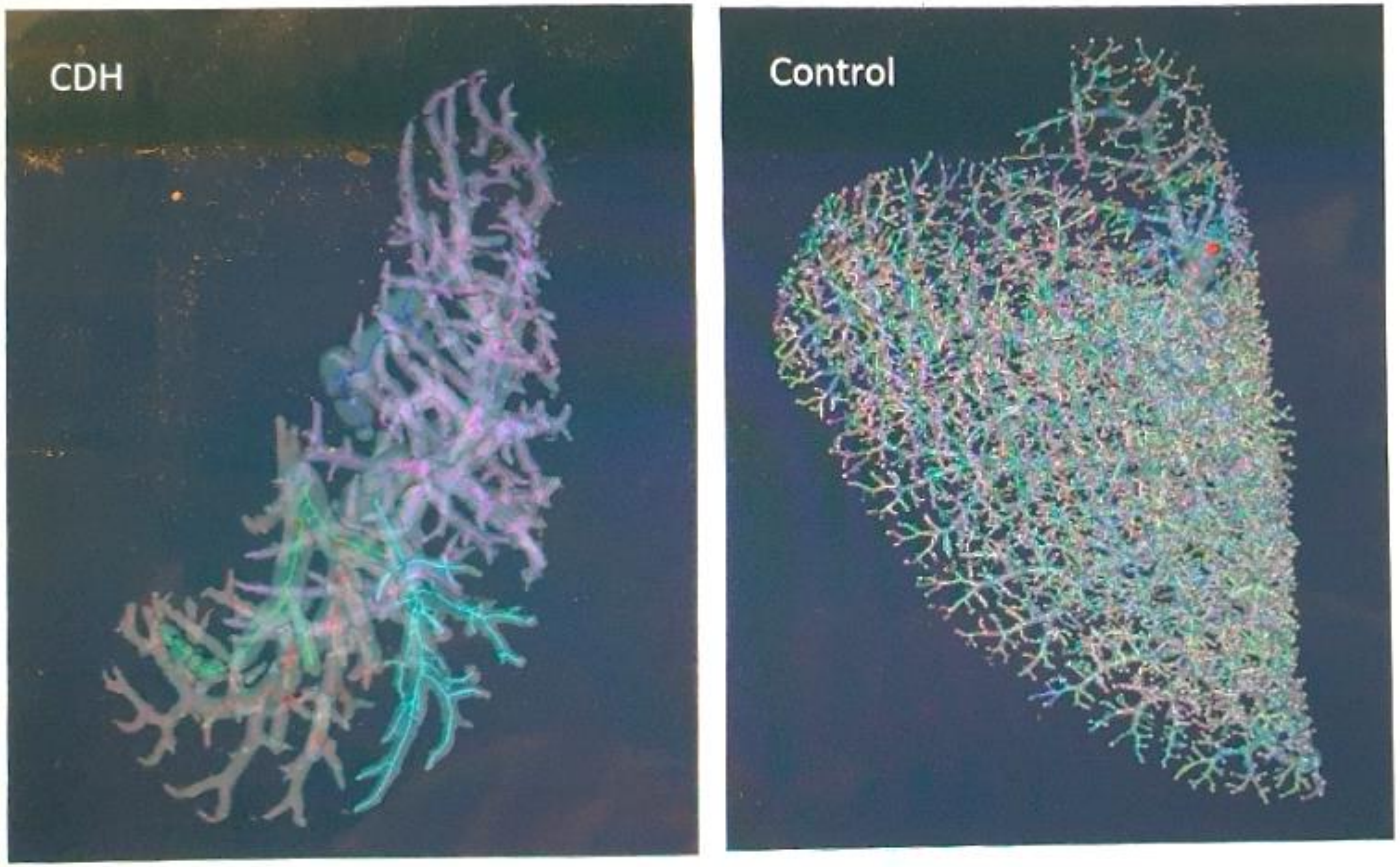
? 2. Increased muscularization of small arteries

? 3. Abnormal myogenic responses in vascular smooth muscle

Cause or consequence

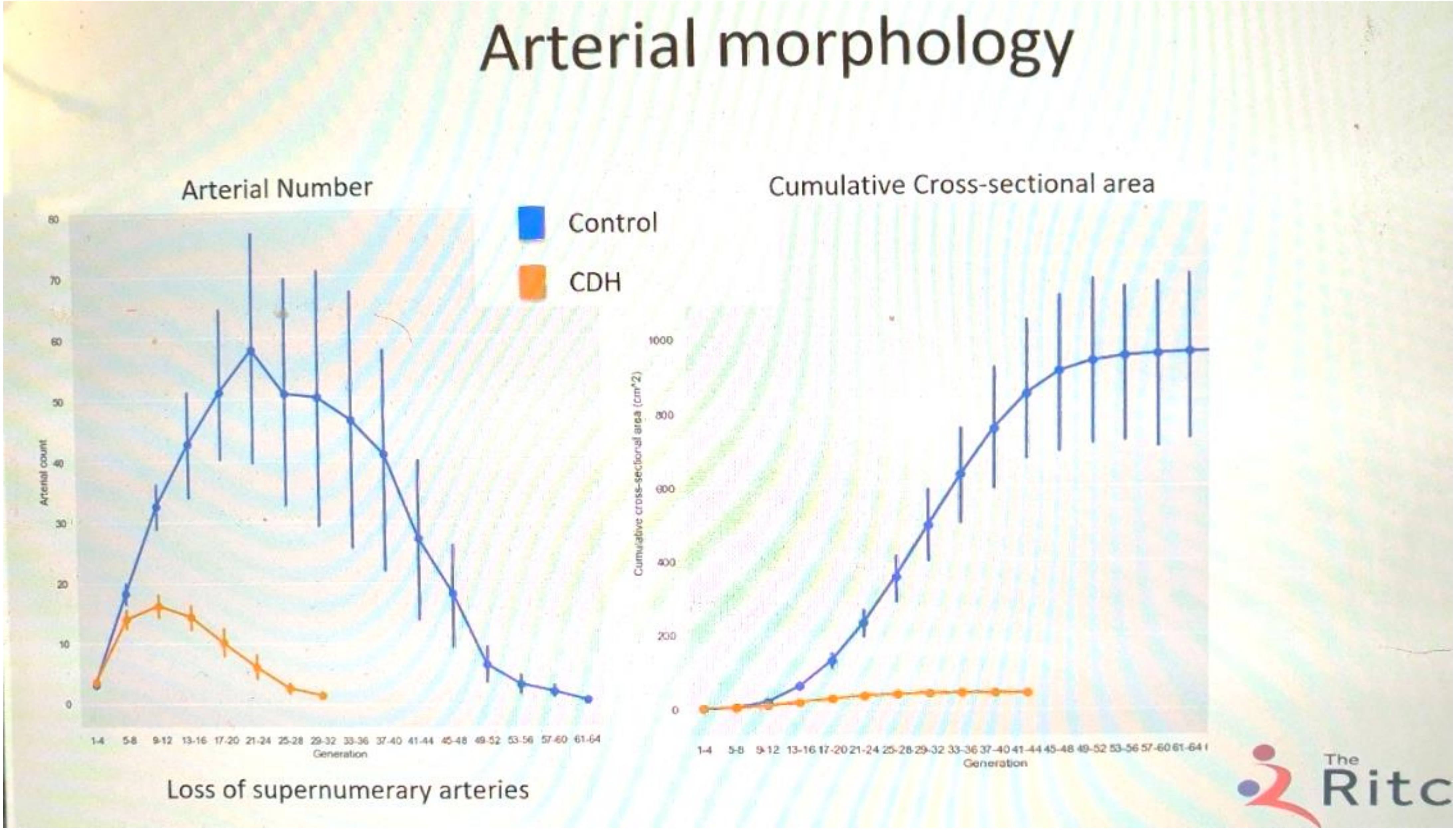
3D CT Scans of Pulmonary Vasculature

Skeletonized 3D Scans of the pulmonary vasculature

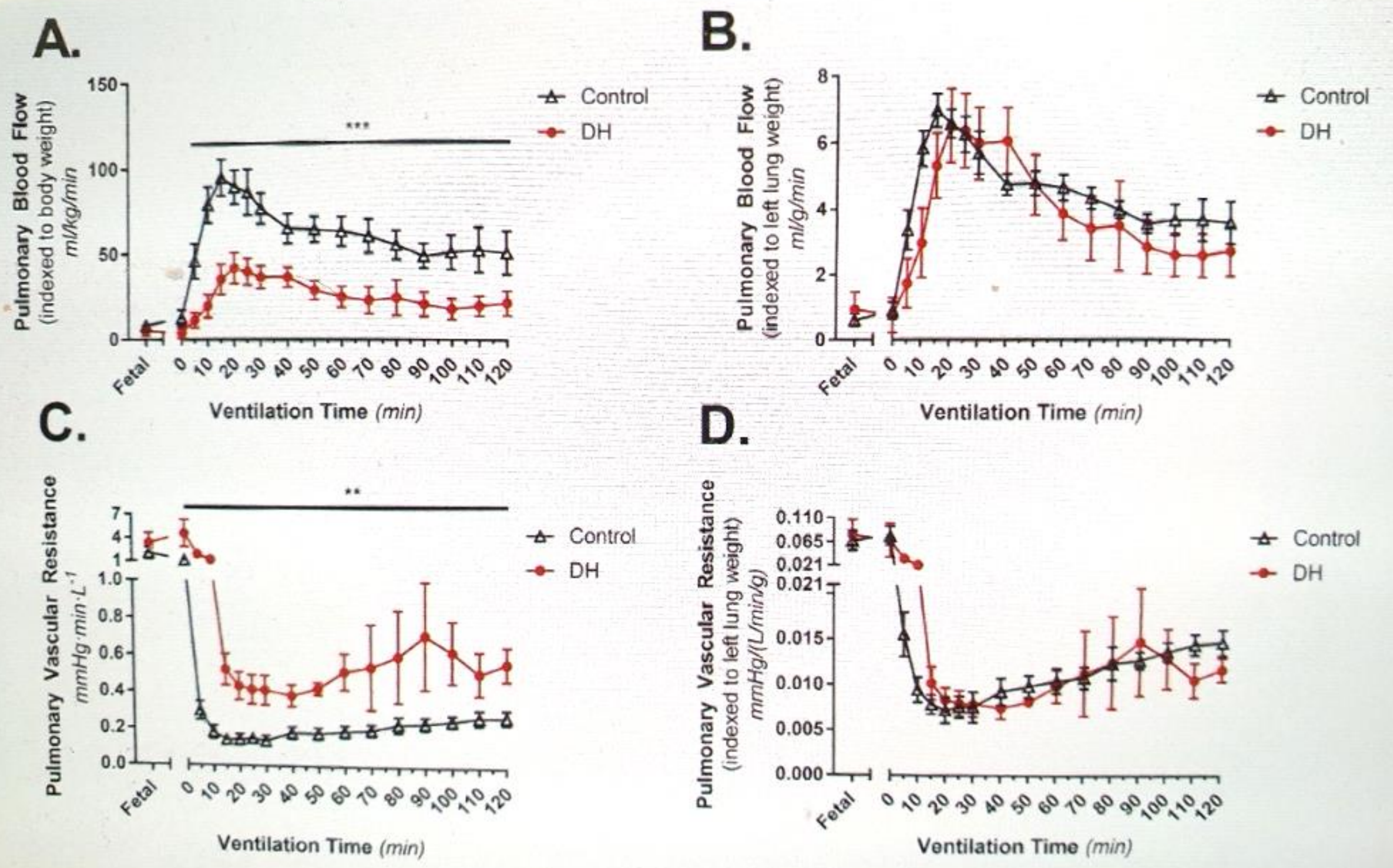


- Contrast agent – Microfil
- 3D CT Scan Voxel res 16µm^3
- Morphometric analysis using Aviso
  segmentation & skeletonization
  of vascular network
- Analysis by arterial hierarchy
  - Artery number
  - Radius
  - Length
  - Branching angle
  - Tortuosity
  - Cumulative volume
  - Cumulative surface area

The Ritchi

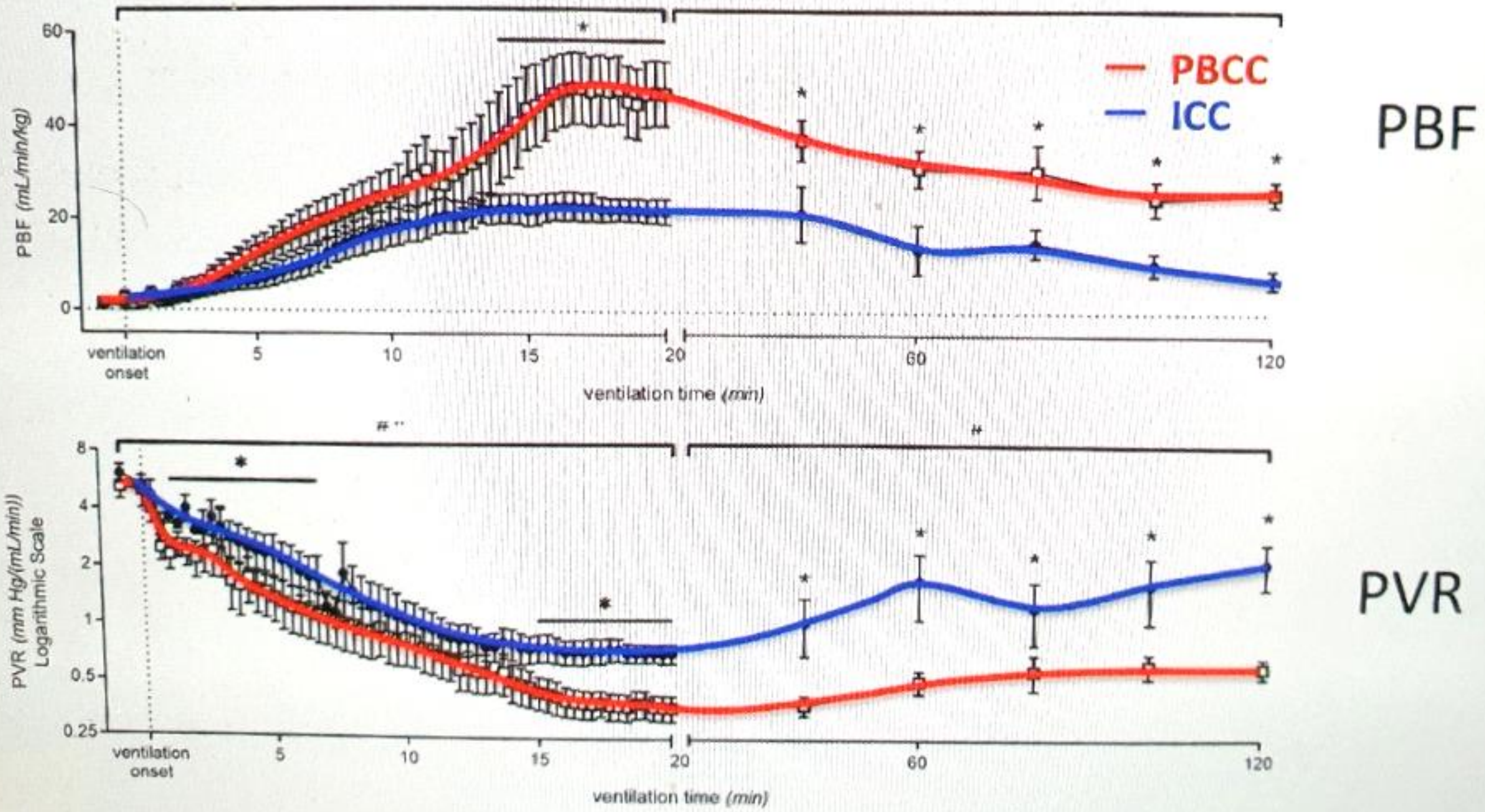

Arterial morphology
Arterial Number
Control
CDH
Arterial count
Generation
1-4 5-8 9-12 13-16 17-20 21-24 25-28 29-32 33-36 37-40 41-44 45-48 49-52 53-56 57-60 61-64
Loss of supernumerary arteries
Cumulative Cross-sectional area
Cumulative cross-sectional area (cm^2)
0 200 400 600 800 1000
Generation
The Ritc

PBF increase at birth in DH Lambs



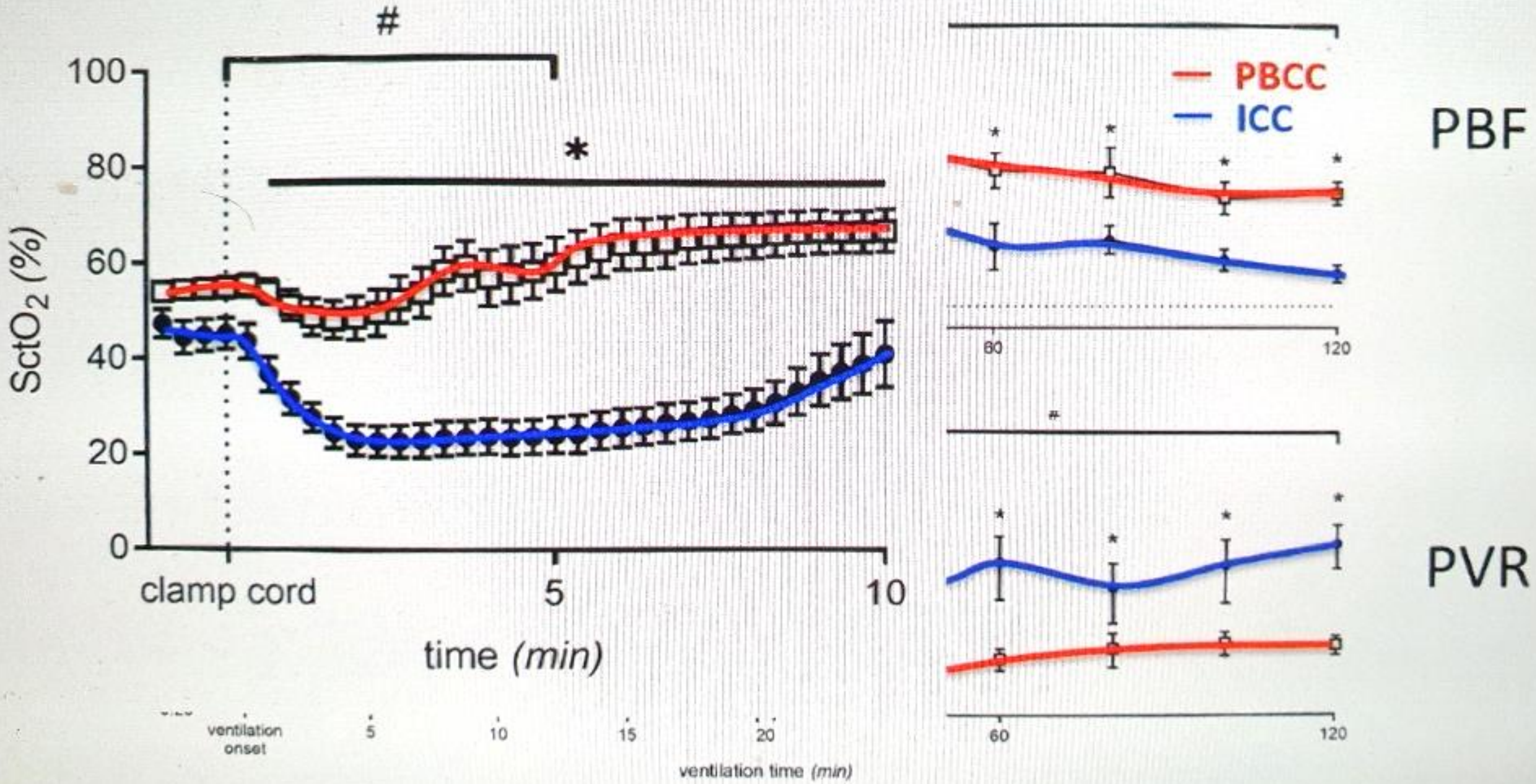
CDH Lambs

Effect of Physiological based cord clamping



CDH Lambs

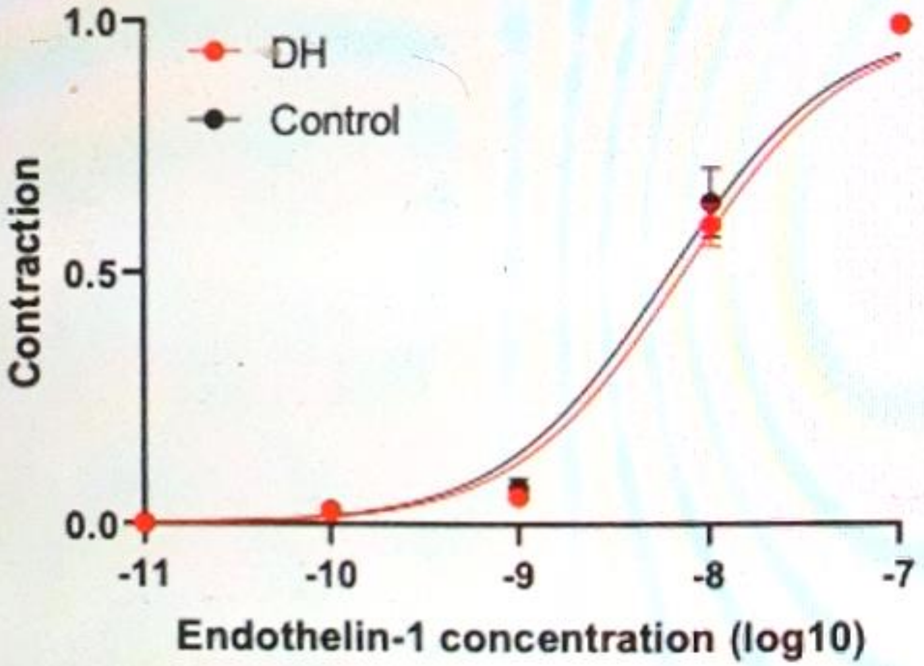
Effect of Physiological based cord clamping



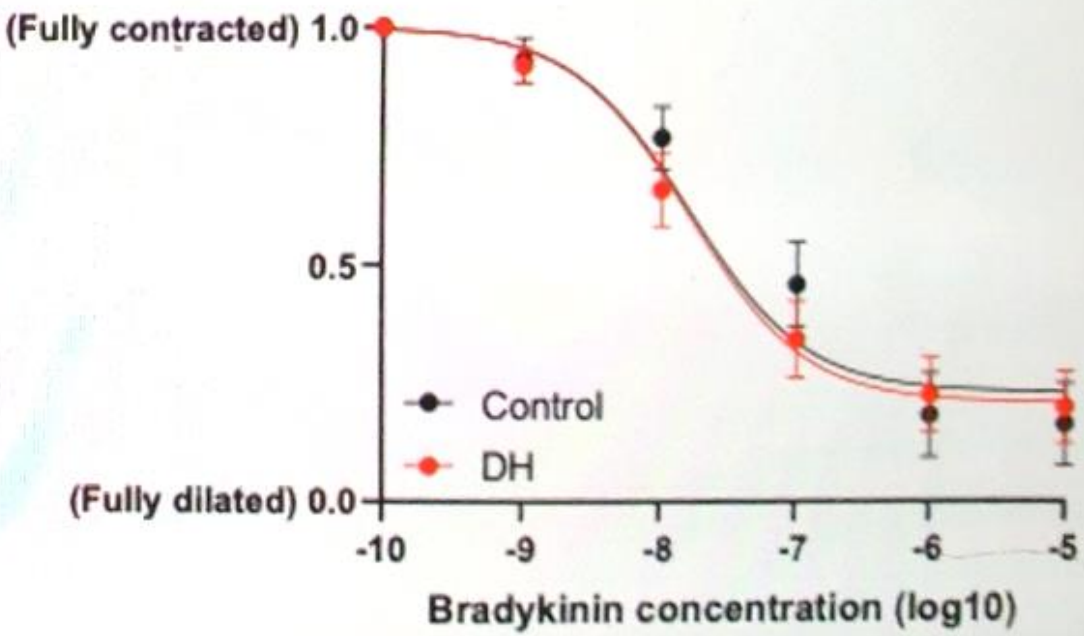
Myography in **Unventilated** lambs

Control Vs DH lambs

Ability to Contract



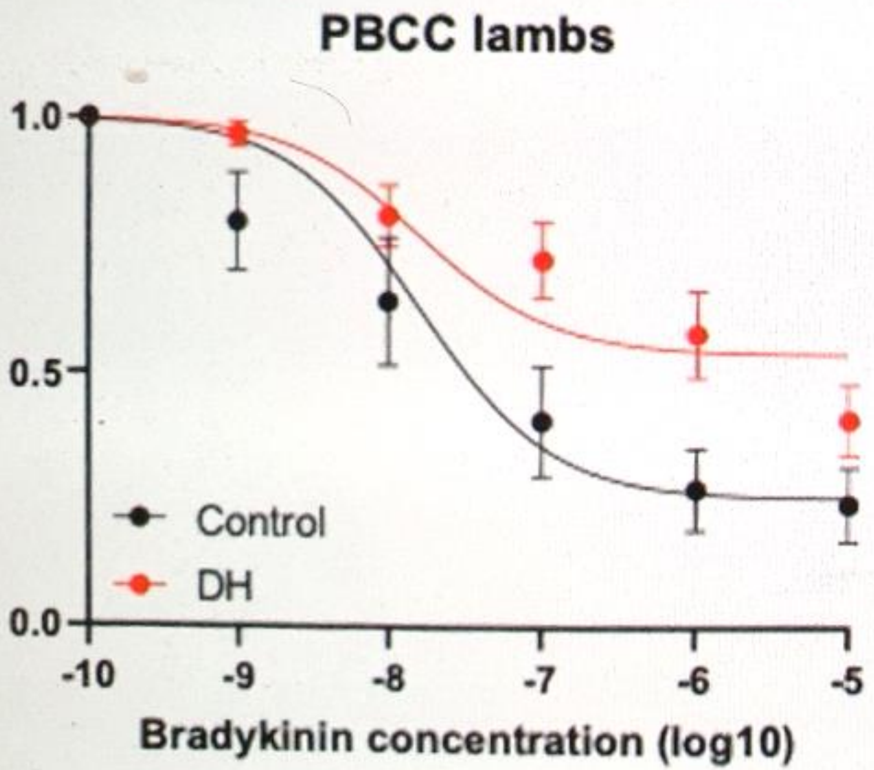
Ability to Relax



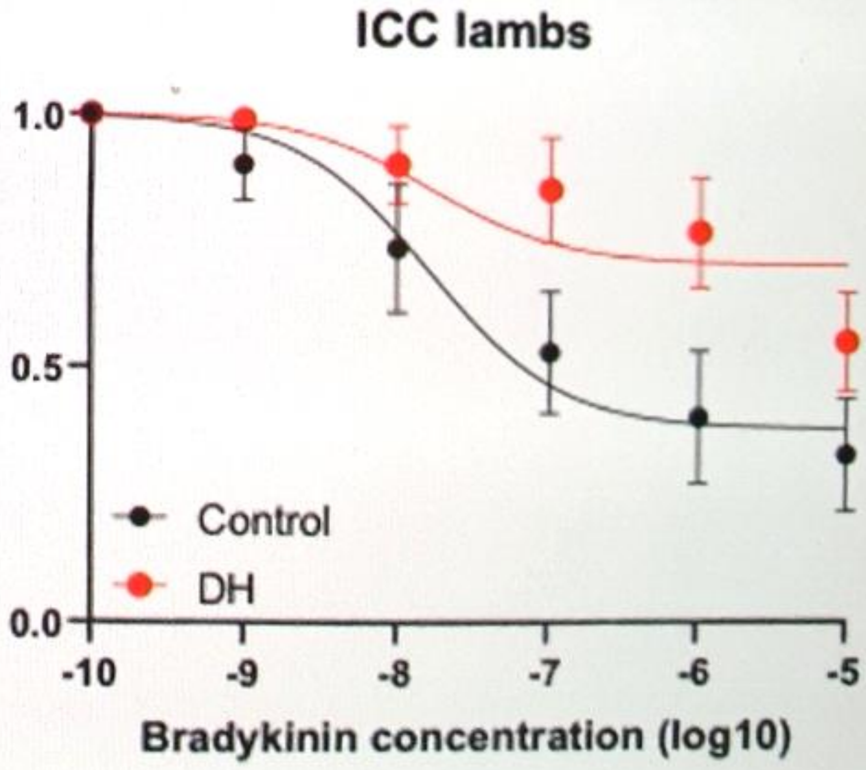
ICC reduces ability to relax

Following ventilation onset

PBCC = Physiological based cord clamping



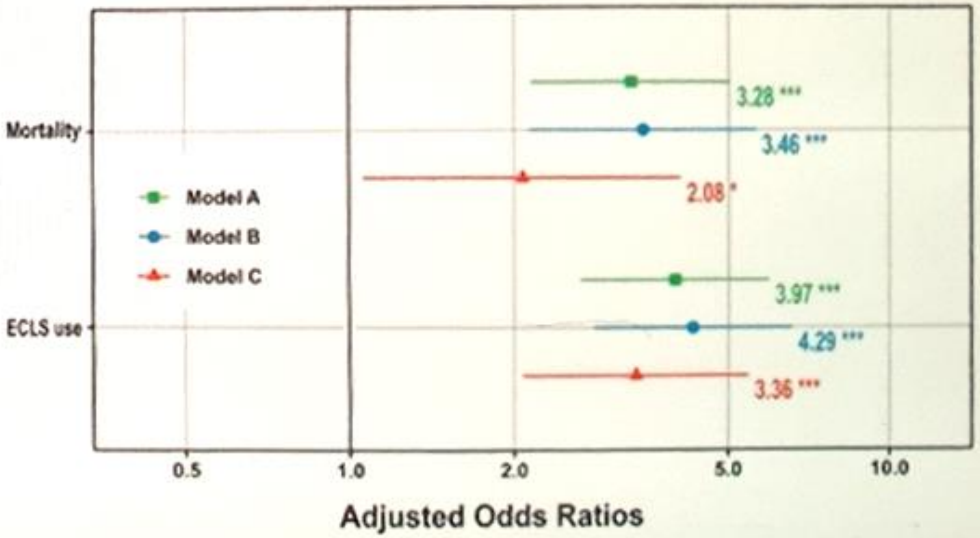
ICC = Immediate cord clamping



iNO in CDH – the controversy continues

Hôpital de Montréal pour enfants
Centre universitaire de santé McGill
Montreal Children's Hospital
McGill University Health Centre

- iNO has not been associated with improved outcomes in RCT including CDH newborns.
- Poster at PAS 2022 by Stanford group using the CDH registry
  - 1777 patients in CDH study group with echo in first 2 days of life
  - No improvement even in isolated RV dysfunction
  - Early iNO use associated with increased mortality and ECLS use even when adjusting:
    - A) echo characteristics (PH, function, shunt pattern), B)+ neonatal characteristics and defect side C) + size and repair



Stanford Children's Health | Lucile Packard Children's Hospital Stanford

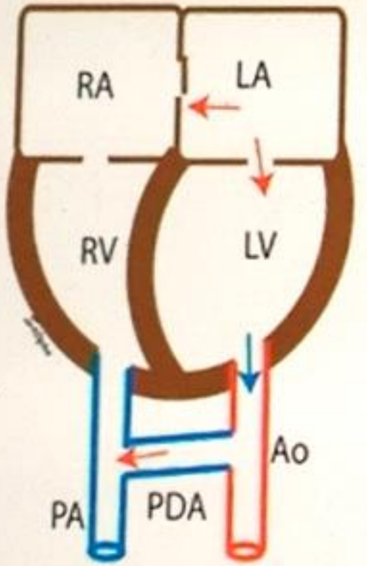
Noh C et al, for the CDH study group, PAS abstract, unpublished data

CDH Pathophysiology Review

by Dr Shazia Bhombal (Stanford University), drawings by Dr Satyan Lakshminrusimha (UC Davis)

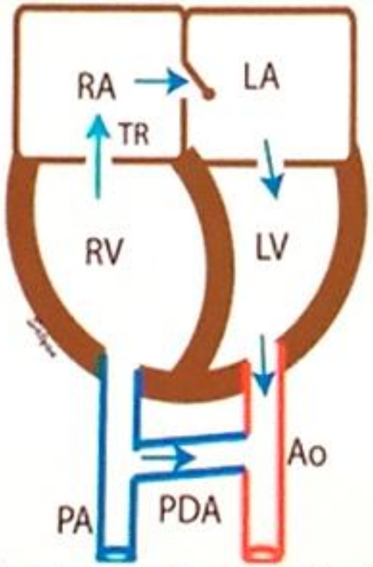
No/mild PH No cardiac dysfunction	PH No cardiac dysfunction/RV dysfunction	PH LV dysfunction/BiV dysfunction
	Pulmonary arterial Phenotype	Pulmonary venous Phenotype

#1



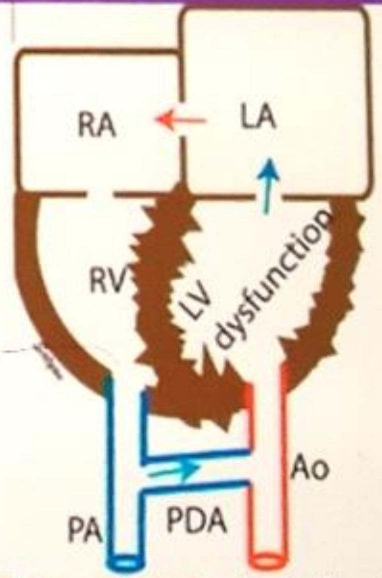
Left to Right atrial shunt
Left to Right PDA

#2

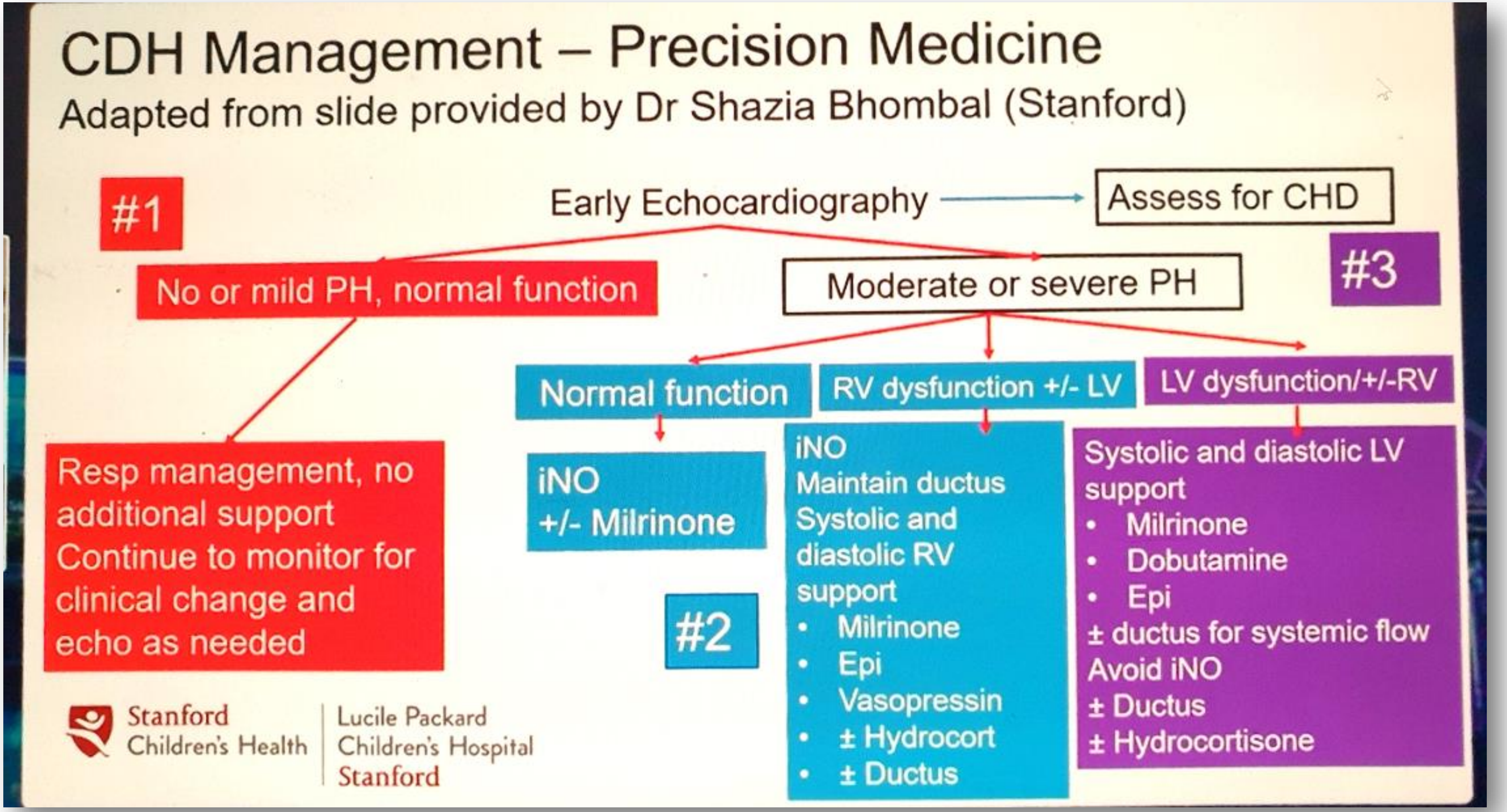


Right to left atrial shunt
Right to left PDA

#3



Left to right atrial shunt
Right to left PDA


CDH Management – Precision Medicine
Adapted from slide provided by Dr Shazia Bhombal (Stanford)
#1
Early Echocardiography
Assess for CHD
No or mild PH, normal function
Moderate or severe PH
#3
Normal function
RV dysfunction +/- LV
LV dysfunction/+/-RV
Resp management, no additional support
Continue to monitor for clinical change and echo as needed
iNO
+/- Milrinone
#2
iNO
Maintain ductus
Systolic and diastolic RV support
• Milrinone
• Epi
• Vasopressin
• ± Hydrocort
• ± Ductus
Systolic and diastolic LV support
• Milrinone
• Dobutamine
• Epi
± ductus for systemic flow
Avoid iNO
± Ductus
± Hydrocortisone
Stanford Children's Health
Lucile Packard Children's Hospital Stanford

Clinical Studies

- Single-center retrospective study
- 392 CDH patients
- 2008-2020
- Standardized protocols

CDH Outcomes – Female vs. Male

Outcome	Exposure = Female	
	Adjusted Odds Ratio (95% CI)	P value
ECMO Use	**0.41 (0.18-0.92)**	**0.03**

Resolution of Pulmonary Hypertension on Echocardiogram at 1 year

Outcome	Male	Female	P value
Pulmonary Hypertension Resolution at 1 Year	**25%**	**49%**	**0.03**

	Male	Female	P value
o/e TFLV median, (IQR)	0.29 (0.23-0.39)	0.31 (0.23-0.41)	0.63

PEDIATRIC PULMONOLOGY

ORIGINAL ARTICLE Full Access

Clinical features and outcomes associated with tracheostomy in congenital diaphragmatic hernia

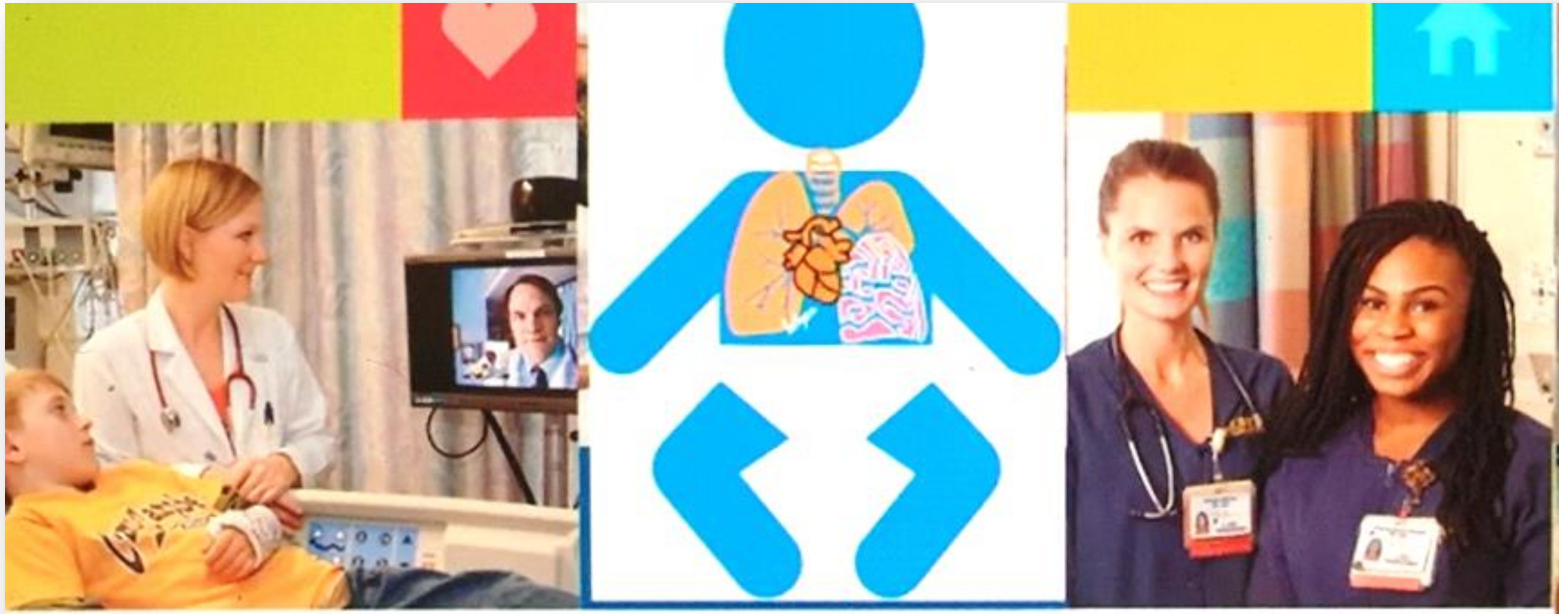
Sahar Al Baroudi MD, Joseph M. Collaco MD, MS, MBA, MPH, PhD, Pamela A. Lally MD, Matthew T. Harting MD, MS, Eric B. Jelin MD ... See fewer authors

Texas Children's

Baylor College of Medicine

Summary

- Clinical data suggests that there are sex-based difference in PH outcomes of neonates born with CDH
- There are sex-based differences in transcriptome and functional differences in proliferation, migration, and tube formation in HUVECs of CDH patients

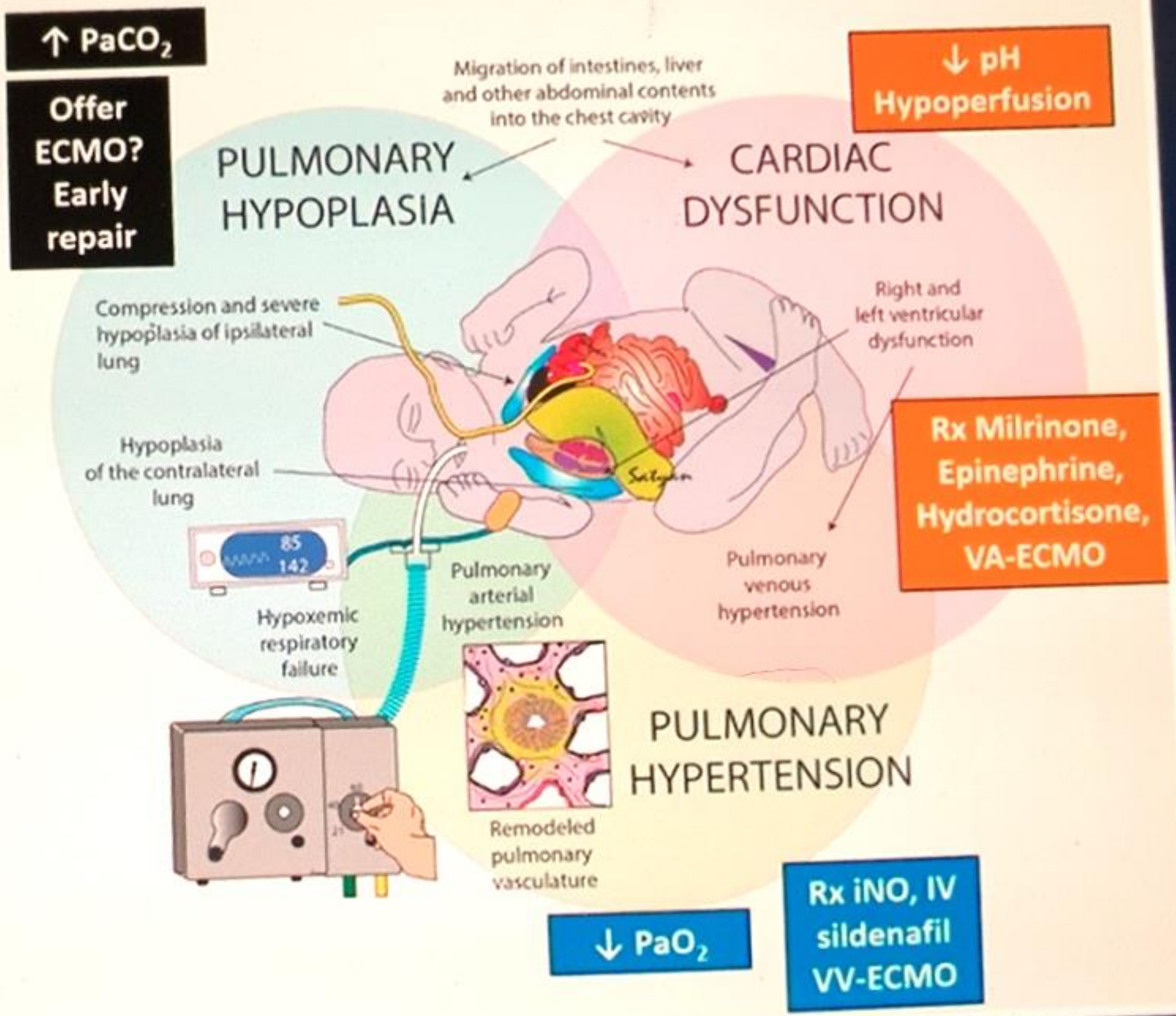


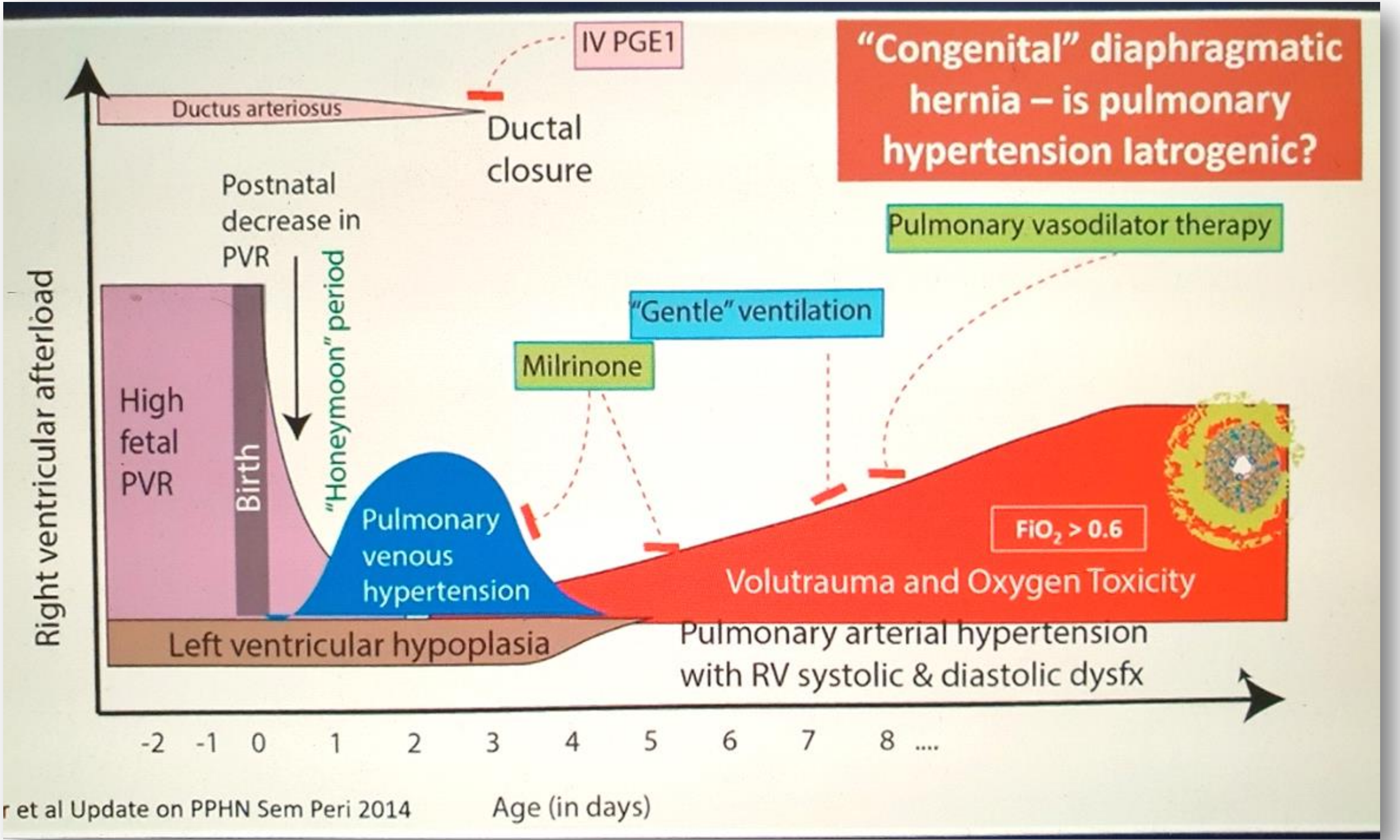
Pulmonary Hypertension in CDH

Satyan Lakshminrusimha, MD FAAP
Professor and Chair of Pediatrics,
Pediatrician-in-Chief, UC Davis Children's
Hospital, Sacramento, California
slakshmi@ucdavis.edu @neosatyan

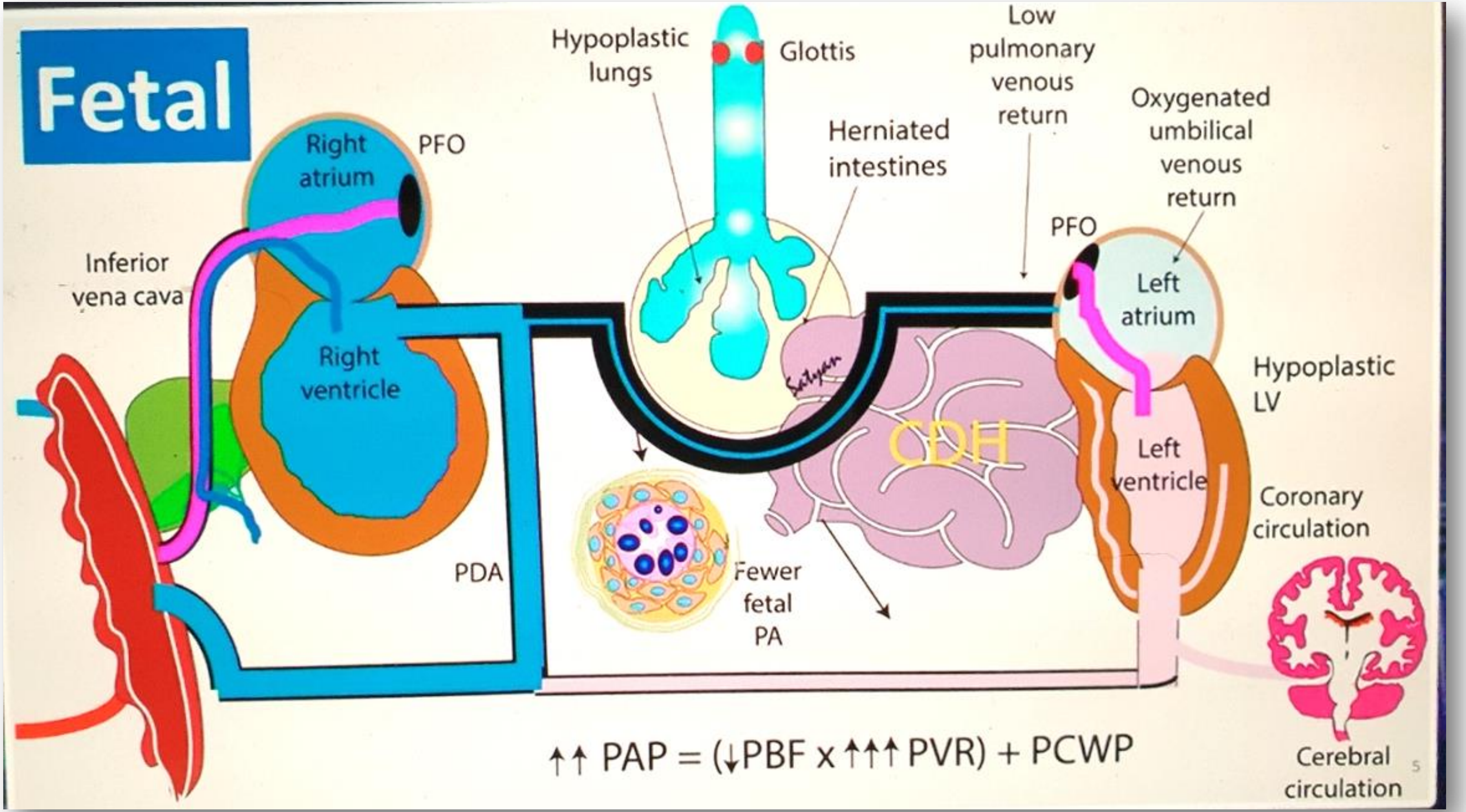
Congenital Diaphragmatic Hernia:

Three Pathologies



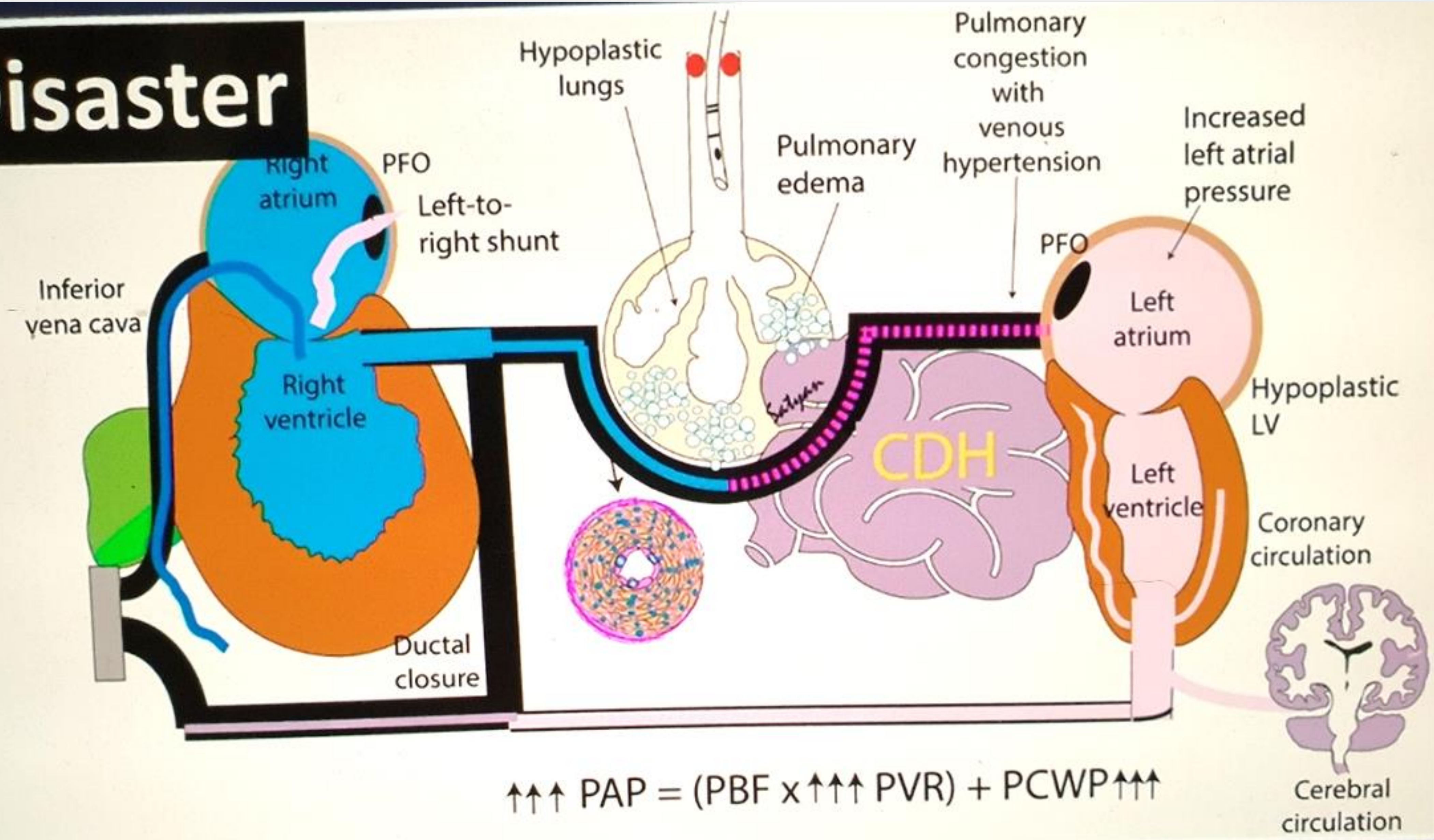


"Congenital" diaphragmatic hernia – is pulmonary hypertension Iatrogenic?
IV PGE1
Ductus arteriosus
Ductal closure
Postnatal decrease in PVR
"Honeymoon" period
Pulmonary vasodilator therapy
"Gentle" ventilation
Milrinone
High fetal PVR
Birth
Pulmonary venous hypertension
FiO$_2$ > 0.6
Volutrauma and Oxygen Toxicity
Left ventricular hypoplasia
Pulmonary arterial hypertension with RV systolic & diastolic dysfx
Right ventricular afterload
-2 -1 0 1 2 3 4 5 6 7 8 ....
Age (in days)
r et al Update on PPHN Sem Peri 2014

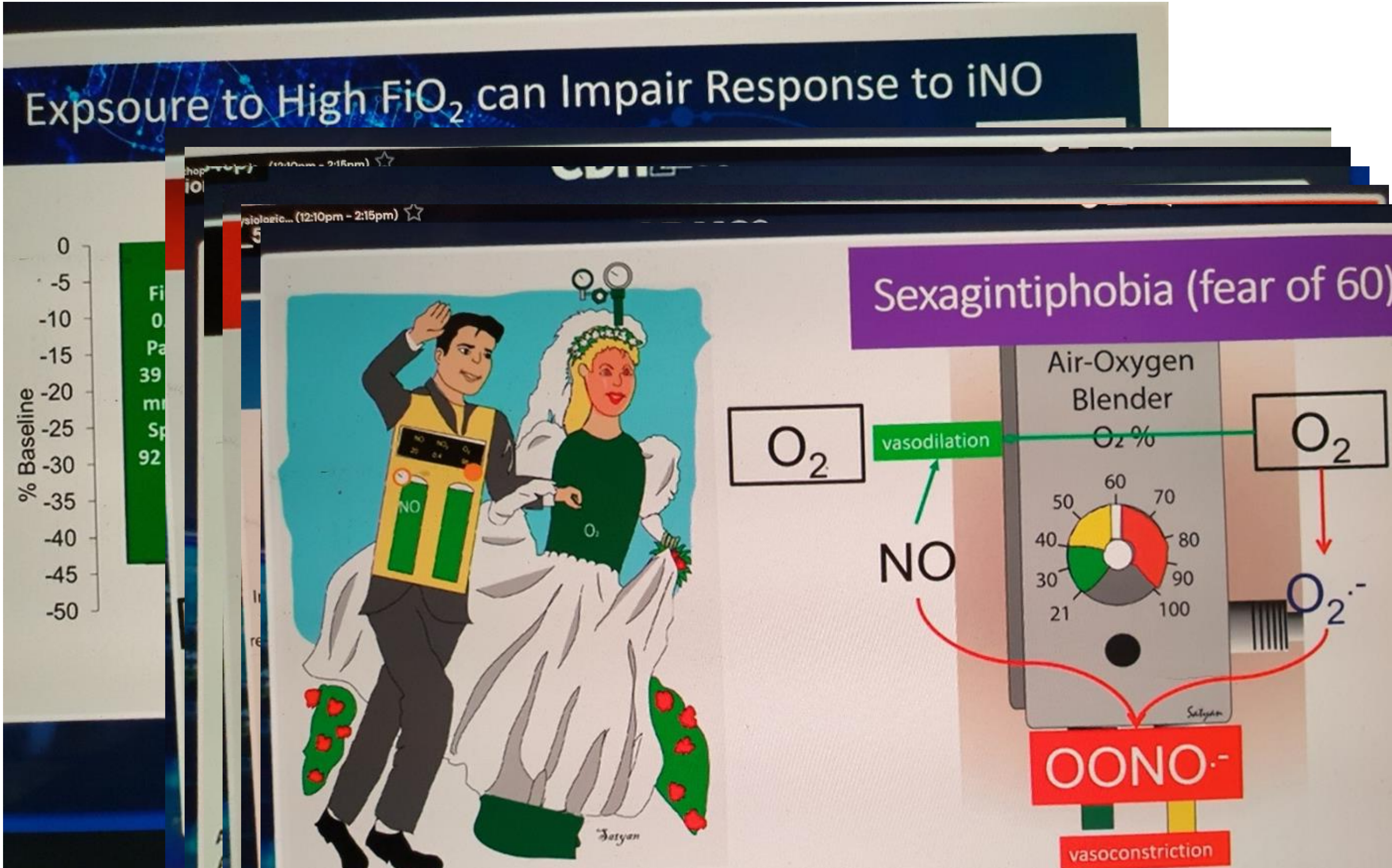


Fetal
Right atrium
PFO
Inferior vena cava
Right ventricle
PDA
Hypoplastic lungs
Glottis
Herniated intestines
Low pulmonary venous return
Oxygenated umbilical venous return
PFO
Left atrium
Hypoplastic LV
Left ventricle
CDH
Coronary circulation
Fewer fetal PA
Cerebral circulation
↑↑ PAP = (↓PBF x ↑↑↑ PVR) + PCWP

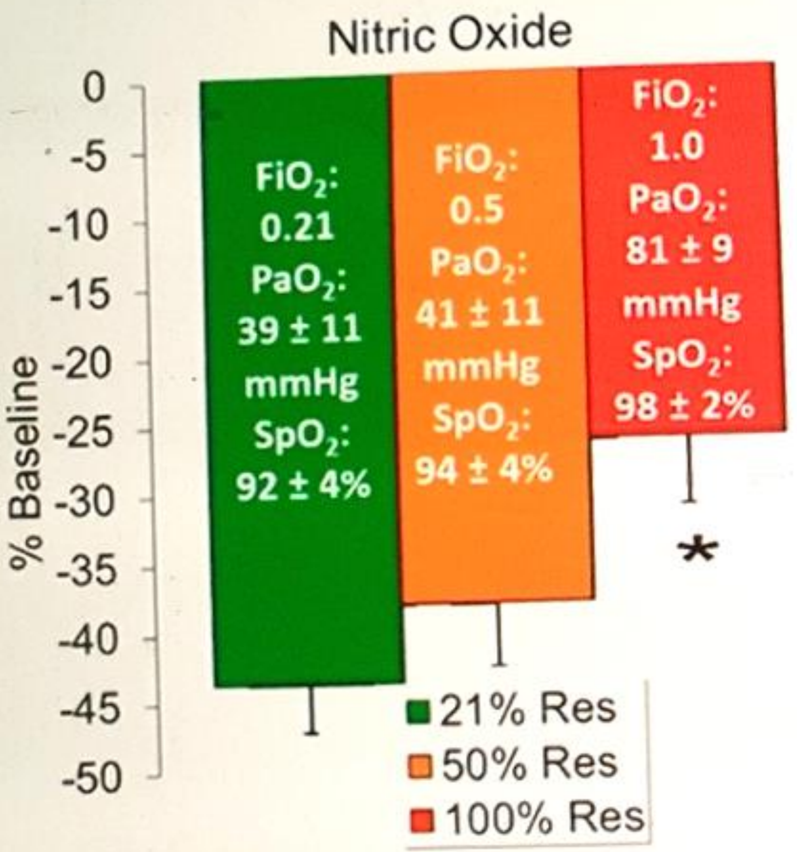
Disaster

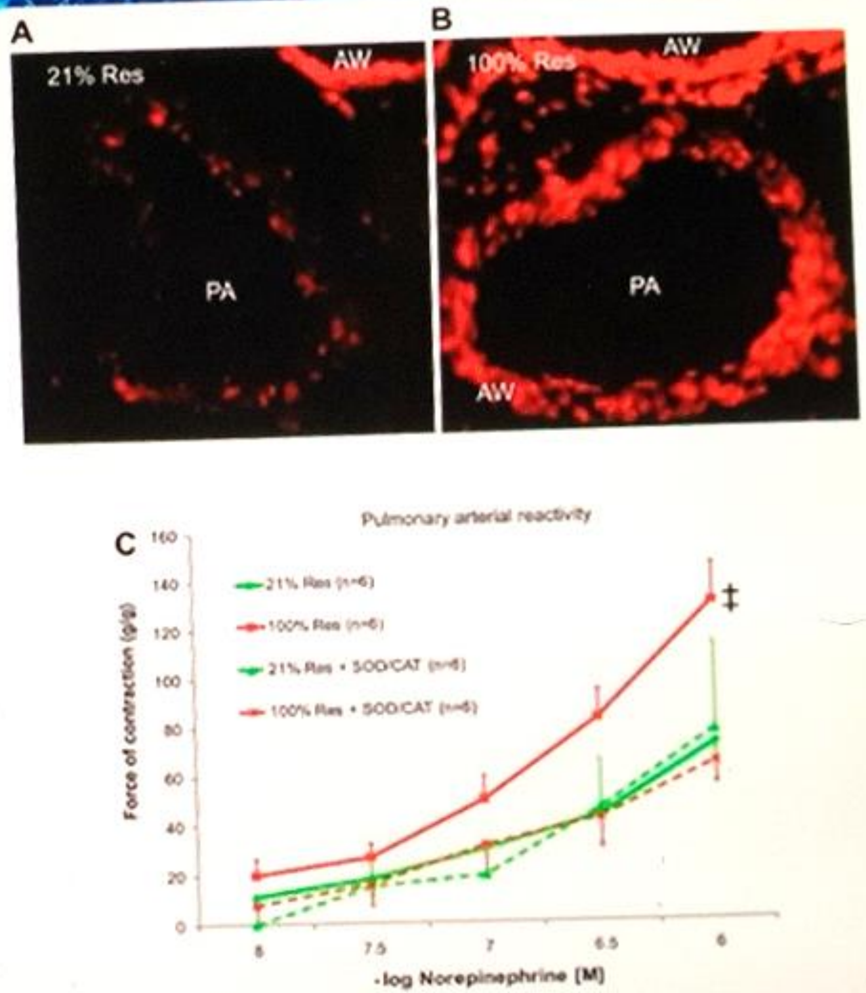


↑↑↑ PAP = (PBF x ↑↑↑ PVR) + PCWP↑↑↑


Expsoure to High FiO2 can Impair Response to iNO
% Baseline
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
(12:10pm - 2:15pm)
Sexagintiphobia (fear of 60
Air-Oxygen
Blender
O2 %
O2
vasodilation
NO
50
60
70
40
80
30
90
21
100
O2·-
OONO·-
vasoconstriction
Satyan

Expsoure to High FiO_2 can Impair Response to iNO

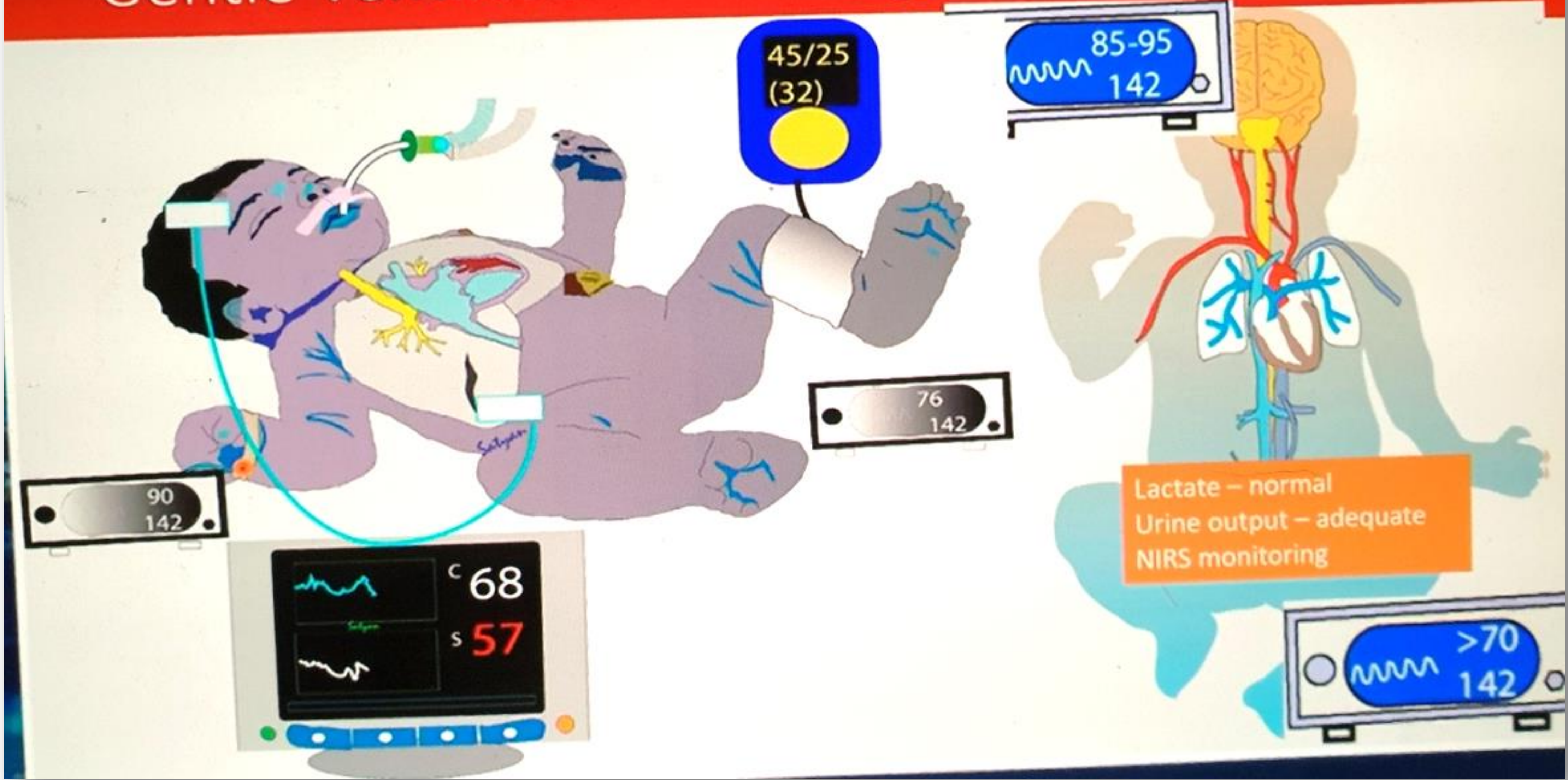




Lakshminrusimha, et al. "Pulmonary hemodynamics in neonatal lambs resuscitated with 21%, 50%, and 100% oxygen." *Pediatric research* 62.3 (2007): 313-318.

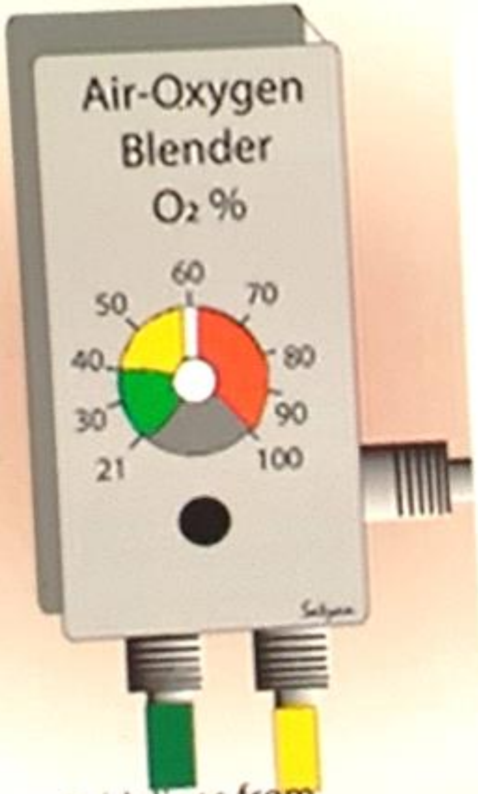
PAS
Pediatric Academic Societies

Gentle Ventilation 101: Target Preductal Oxygen



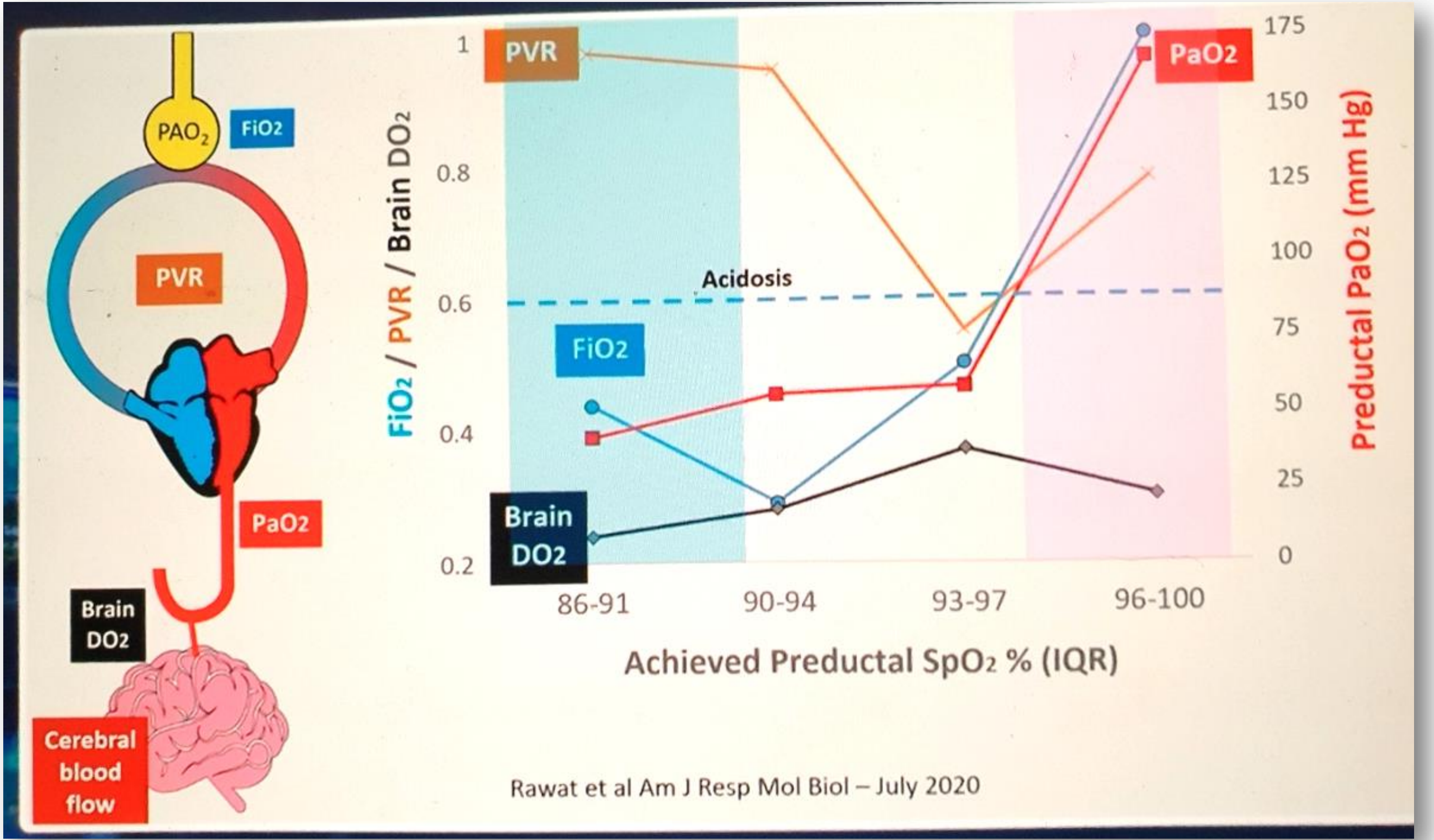
Importance of FiO_2 – Benefits and Risks
Sexagintiphobia (Fear of 60 or > 60% O_2)

If FiO_2 is < 0.6,
Try to maintain preductal SpO_2 in the low-to-mid 90s
Benefit of pulmonary vasodilation > oxygen toxicity

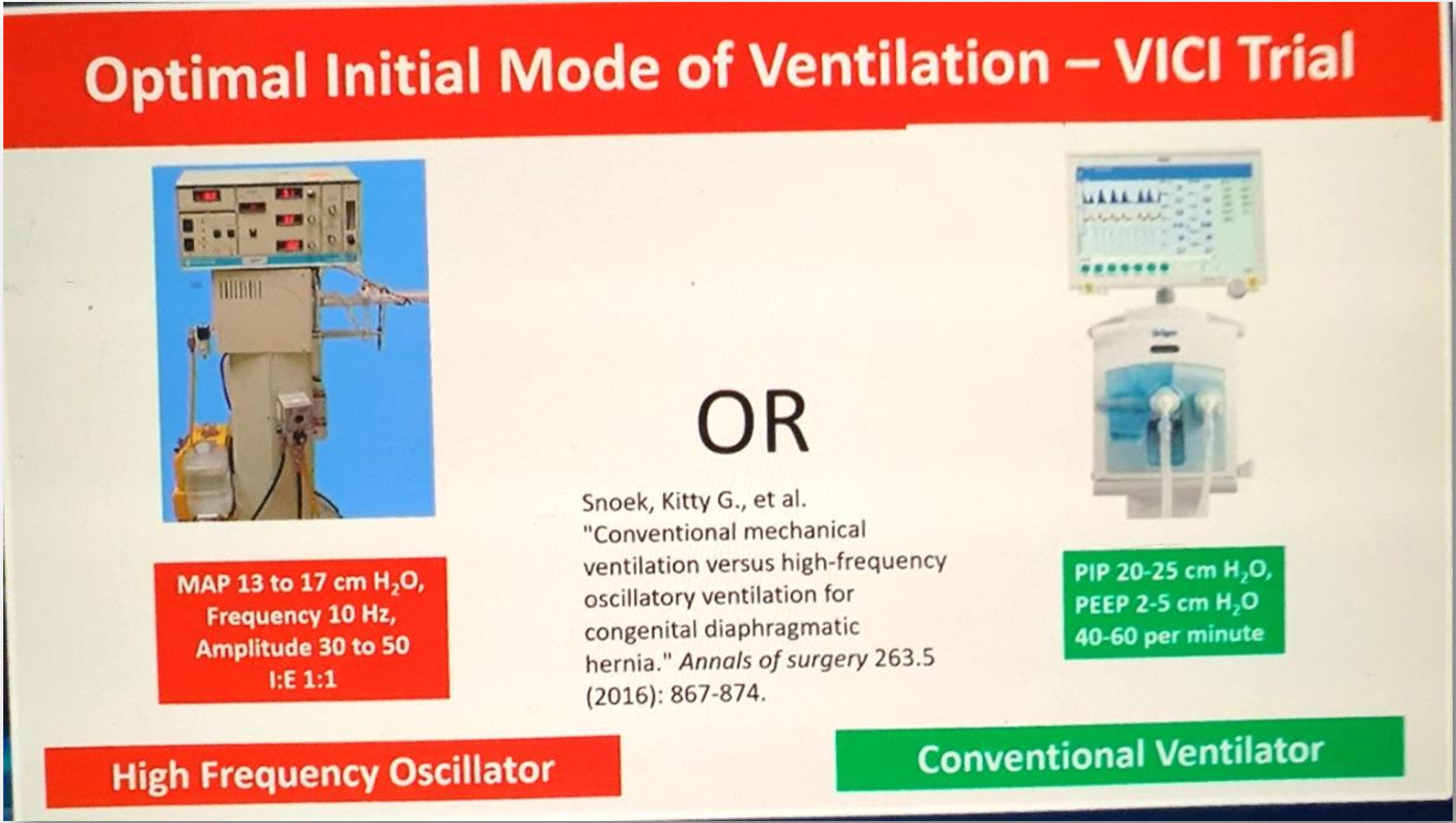


If FiO_2 is > 0.6,
Try to tolerate preductal SpO_2 in the 85-95% range and watch NIRS, lactate & urine output
Oxygen toxicity > risk of hypoxic pulmonary vasoconstriction

Abman et al Pediatric Pulmonary Hypertension – Guidelines from ATS/AHA 2015

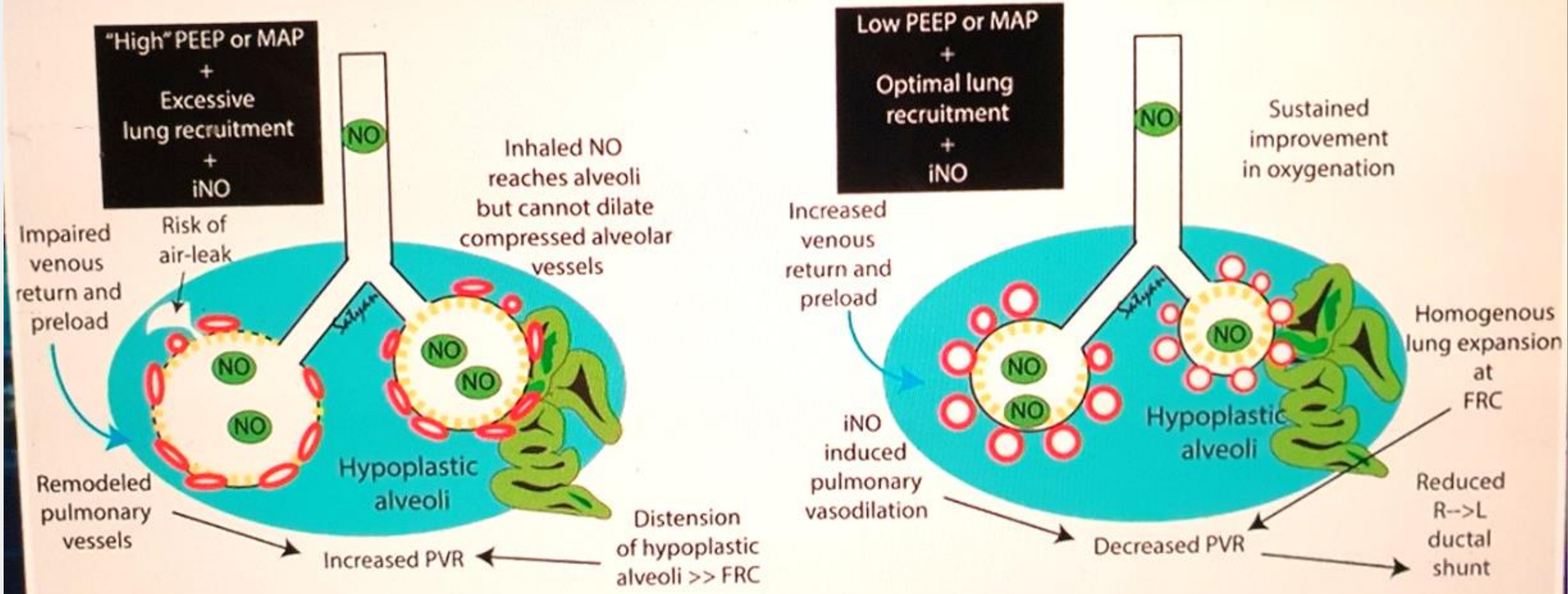


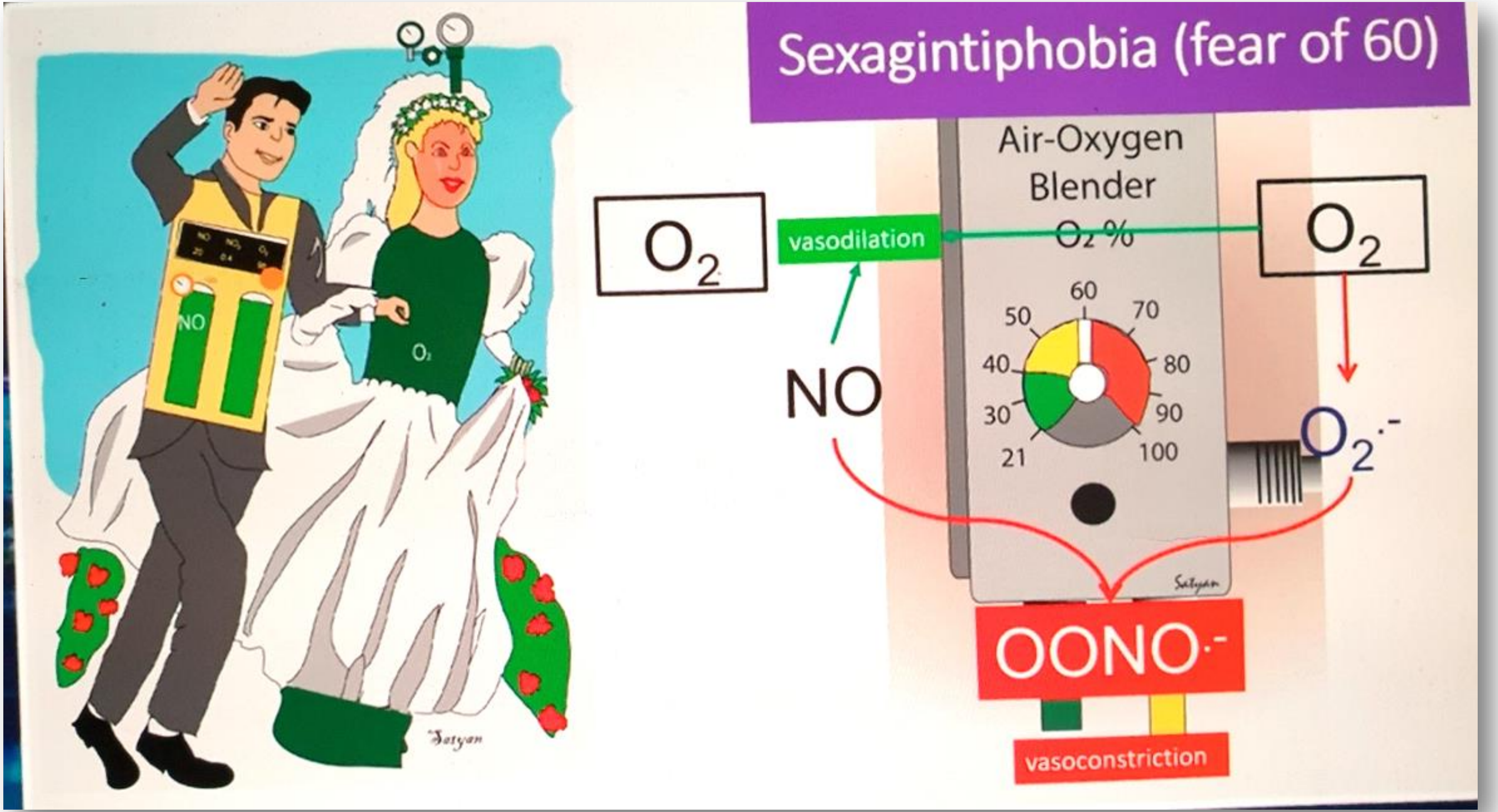
PAO2
FiO2
PVR
PaO2
Brain DO2
Cerebral blood flow
1
0.8
0.6
0.4
0.2
FiO2 / PVR / Brain DO2
PVR
Acidosis
FiO2
Brain DO2
PaO2
175
150
125
100
75
50
25
0
Preductal PaO2 (mm Hg)
86-91
90-94
93-97
96-100
Achieved Preductal SpO2 % (IQR)
Rawat et al Am J Resp Mol Biol – July 2020



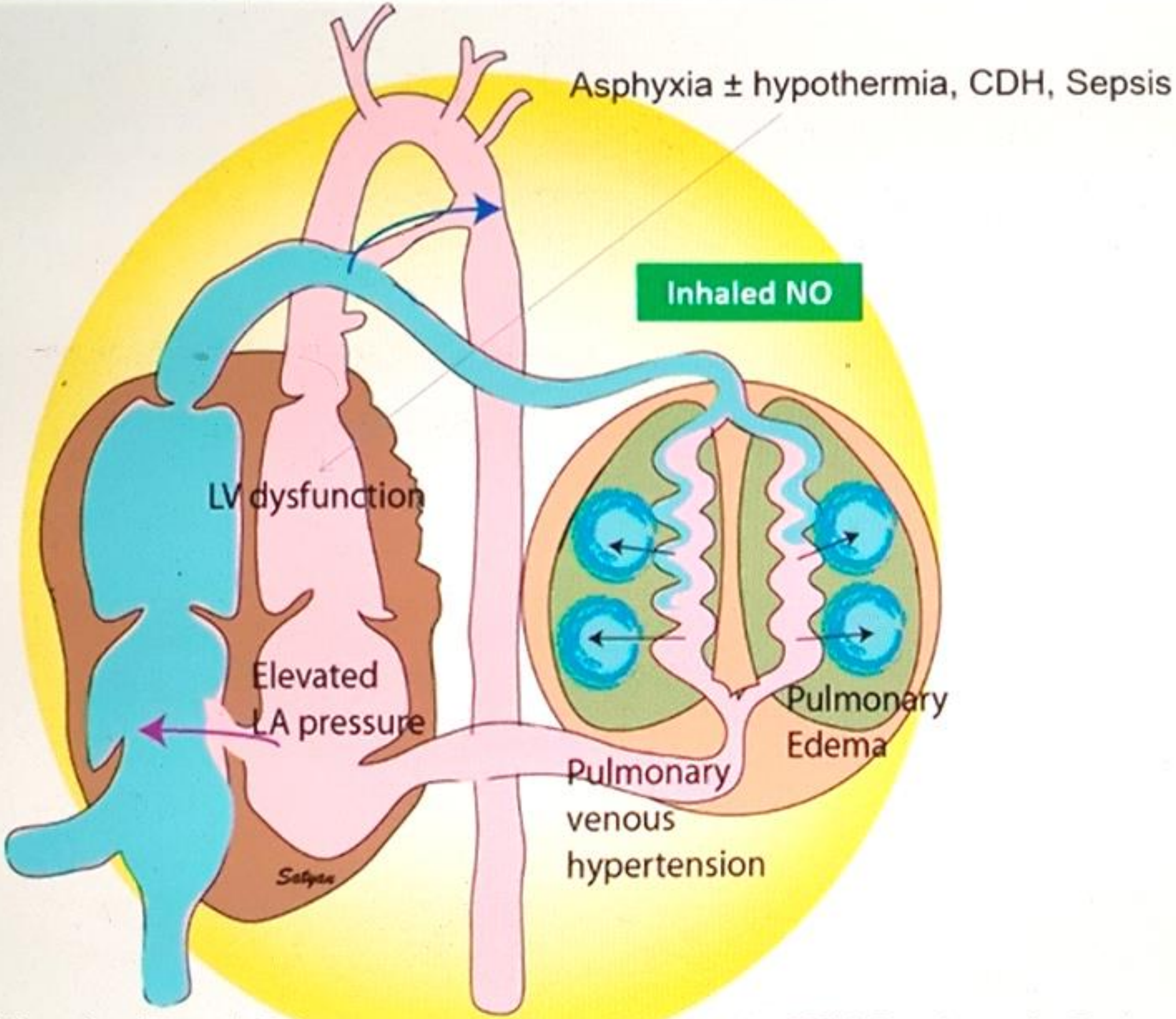
Optimal Initial Mode of Ventilation – VICI Trial
OR
Snoek, Kitty G., et al. "Conventional mechanical ventilation versus high-frequency oscillatory ventilation for congenital diaphragmatic hernia." Annals of surgery 263.5 (2016): 867-874.
MAP 13 to 17 cm H2O, Frequency 10 Hz, Amplitude 30 to 50 I:E 1:1
PIP 20-25 cm H2O, PEEP 2-5 cm H2O 40-60 per minute
High Frequency Oscillator
Conventional Ventilator

Optimal Lung Inflation in CDH



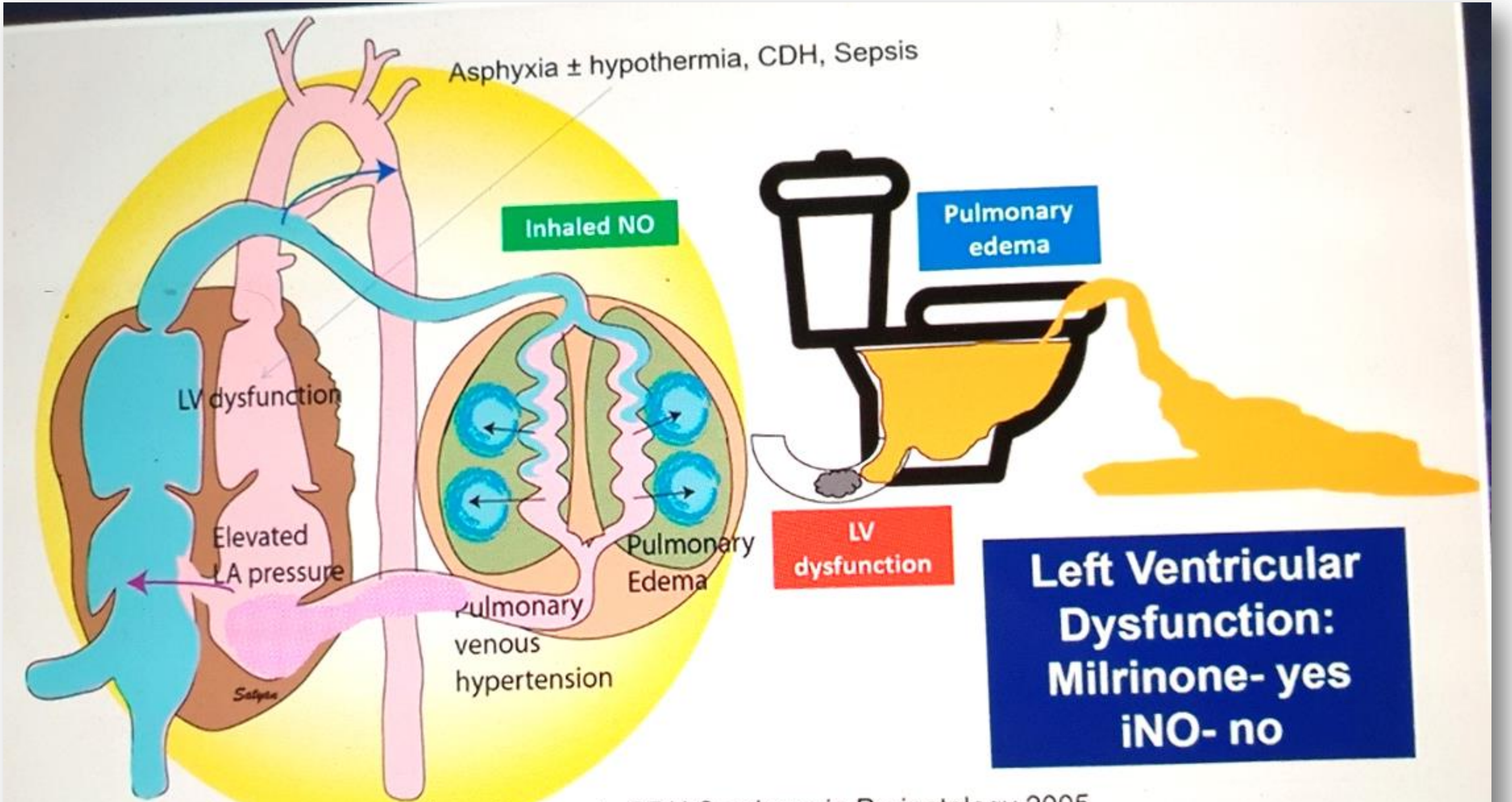


Sexagintiphobia (fear of 60)
NO
O2
O2
vasodilation
Air-Oxygen
Blender
O2 %
60
50
70
40
80
30
90
21
100
O2
NO
O2·-
OONO·-
vasoconstriction

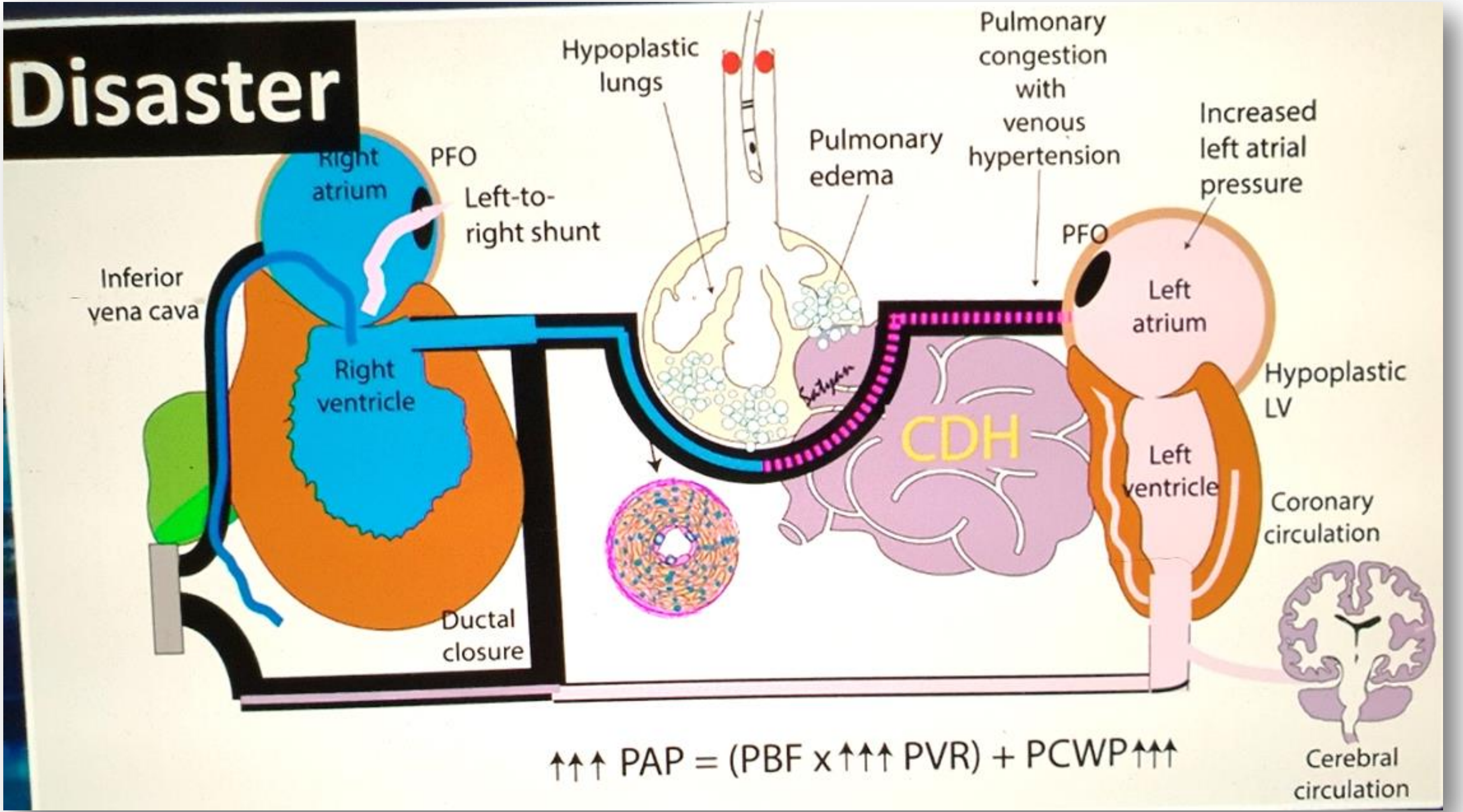


Left Ventricular Dysfunction:

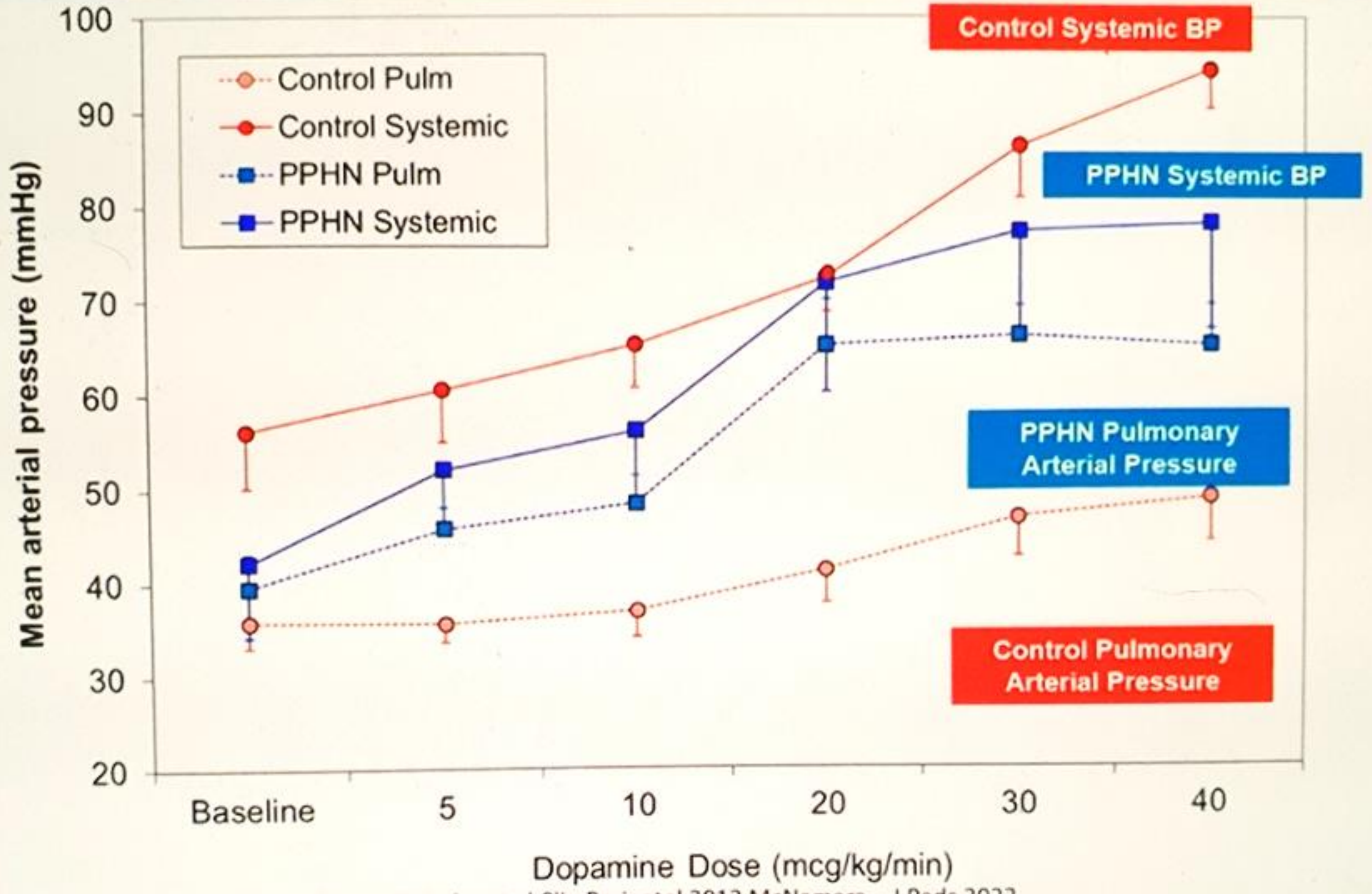
Kinsella JP et al Pulmonary vasodilator therapy in CDH Seminars in Perinatology 2005



Kinsella JP et al Pulmonary vasodilator therapy in CDH Seminars in Perinatology 2005

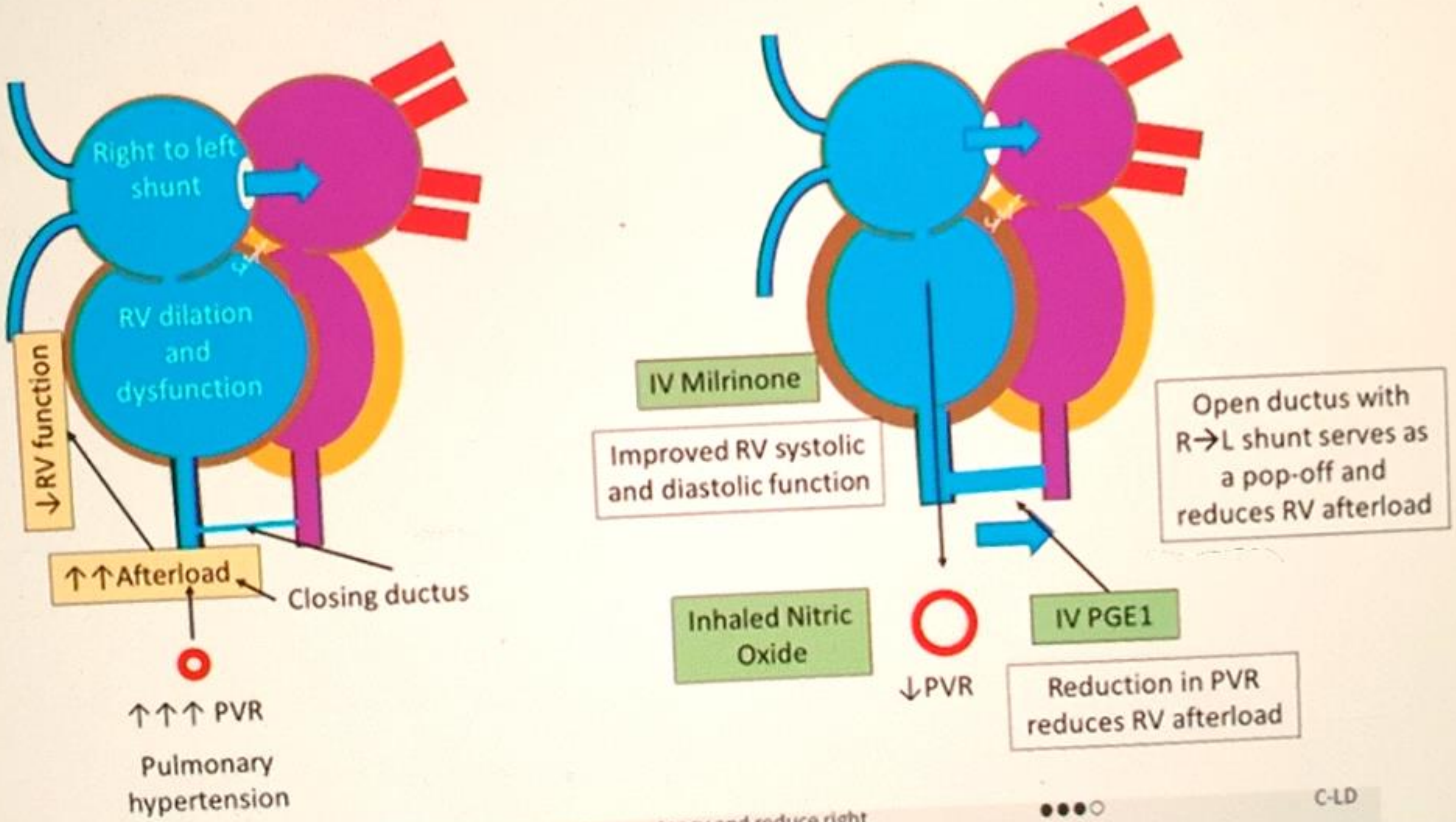

Disaster
Hypoplastic lungs
Pulmonary congestion with venous hypertension
Increased left atrial pressure
Pulmonary edema
Right atrium
PFO
Left-to-right shunt
PFO
Left atrium
Inferior vena cava
Right ventricle
CDH
Hypoplastic LV
Left ventricle
Coronary circulation
Ductal closure
Cerebral circulation
↑↑↑ PAP = (PBF x ↑↑↑ PVR) + PCWP↑↑↑

CAUTION: Dopamine & Selectivity to Systemic Circulation



Kirmani et al E PAS 2007; Lakshminrusimha et al Clin Perinatol 2012 McNamara – J Peds 2022

Use of IV PGE1 for Ductal Patency



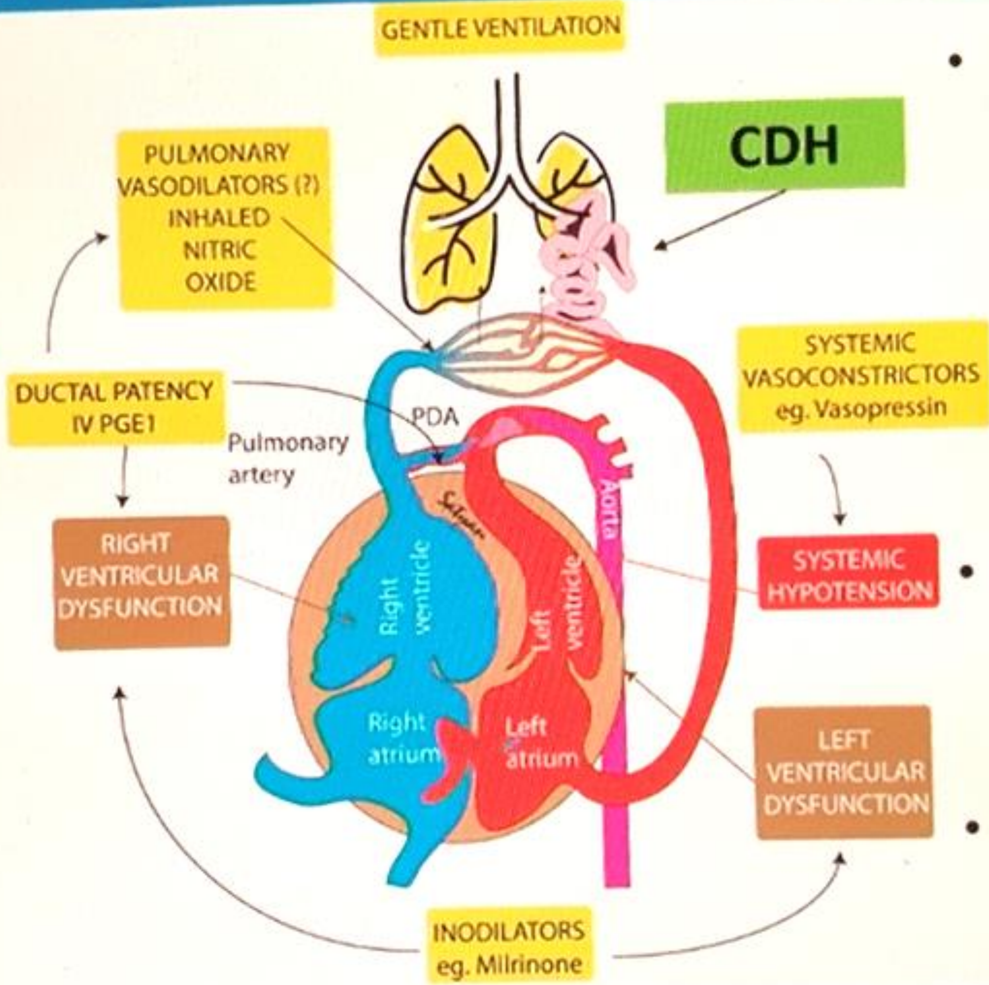
C-LD

Prostaglandin E$_1$ can be used to maintain ductus arteriosus patency and reduce right ventricular afterload in patients with pulmonary hypertension with right ventricular failure, or in the presence of a closing ductus.

An Evidence-Based Approach to Diagnose and Manage PH in Congenital Diaphragmatic Hernia – **Mimic the Fetus**

- PULMONARY HYPOPLASIA: Gentle, lung protective ventilation, **SpO_2 targets in the low-90s (mid-90s if acidotic and $FiO_2 < 0.6$)**

- **Consider low PEEP**
- **Reasonable Hgb (fetal preferred)**
  - **↓iatrogenic loss**
  - **↑Placental transfusion**



- PULMONARY HYPERTENSION: Pulmonary **vasodilators iNO – (keep $FiO_2 < 0.6$)**, sildenafil, bosentan, prostaglandins) and correction of systemic hypotension
- VENTRICULAR DYSFUNCTION: Early use of inodilators (**milrinone**)
- DUCTAL PATENCY: with **PGE1** for pop-off

To intubate or not?

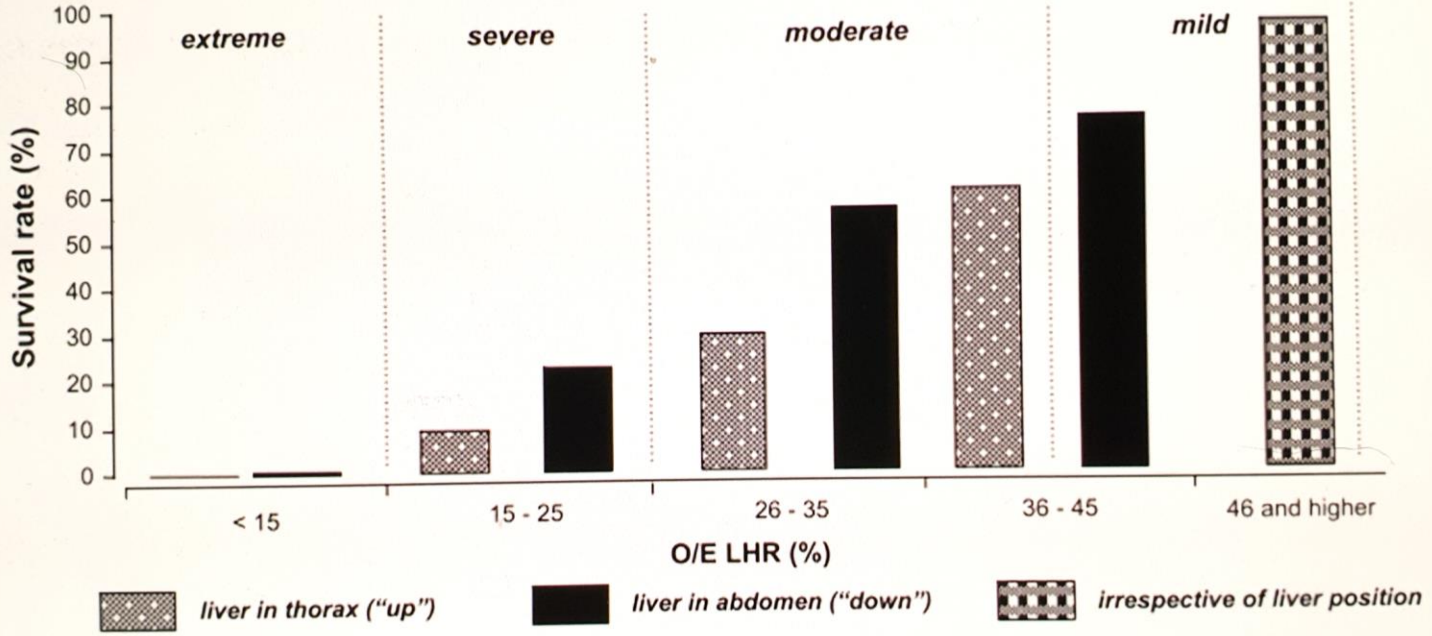


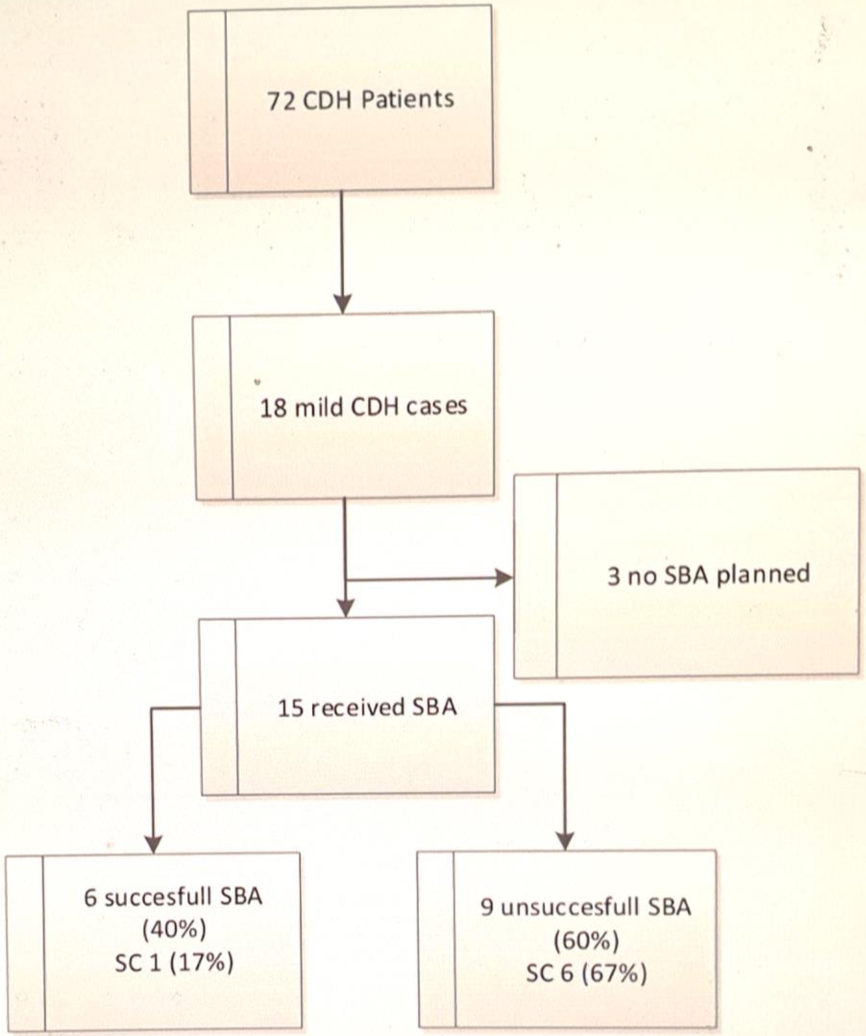
Fig. 2. Survival rates depending on observed/expected lung:head ratio (O/E LHR) measurements and liver position as in the antenatal congenital diaphragmatic hernia registry. (Based on data from Jani et al.[11]).

Erasmus MC Sophia Children's Hospital

(Deprest, Flemmer et al. 2009)

SBA

- Mild:
  L-CDH
  O/E LHR ≥50
  Liver down
  No anomalies



Erasmus MC
Sophia Children's Hospital

(Cochius – den Otter et al. Pediatrics 2020)

SBA

	Successful SBT (n=6) Median / %	Failed SBT (n=9) Median (IQR)	p-value
Apgar score 5 minutes	8 (8-9)	7 ((7-9)	0.18
Peak ventilator pressure	23.5 (21.5-27)	23 (19.5-25)	0.37
Days on ventilator	1 (1-2.5)	7 (4-10)	0.004
Maximum FiO2 on the ventilator	60 (40-79)	50 (37.5-75)	0.64
Total oxygen therapy (days)	4.5 (2.5-7)	15 (5-17)	0.037

(Cochius – den Otter et al. Pediatrics 2020)

Resuscitation of Infants with an Intact Umbilical Cord

- C Section deliveries – infant placed on maternal legs
- Vaginal Deliveries – infant placed on maternal abdomen

- Infant intubated with umbilical cord intact
- Positive Pressure Ventilation initiated with T Piece Resuscitation
- 25/5 rate 40-60 50% Oxygen
- RN place preductal pulse-oximeter
- HR < 60 bpm for > 60 seconds after initiation of Ventilation FiO2 Increased to 100%

Ltd

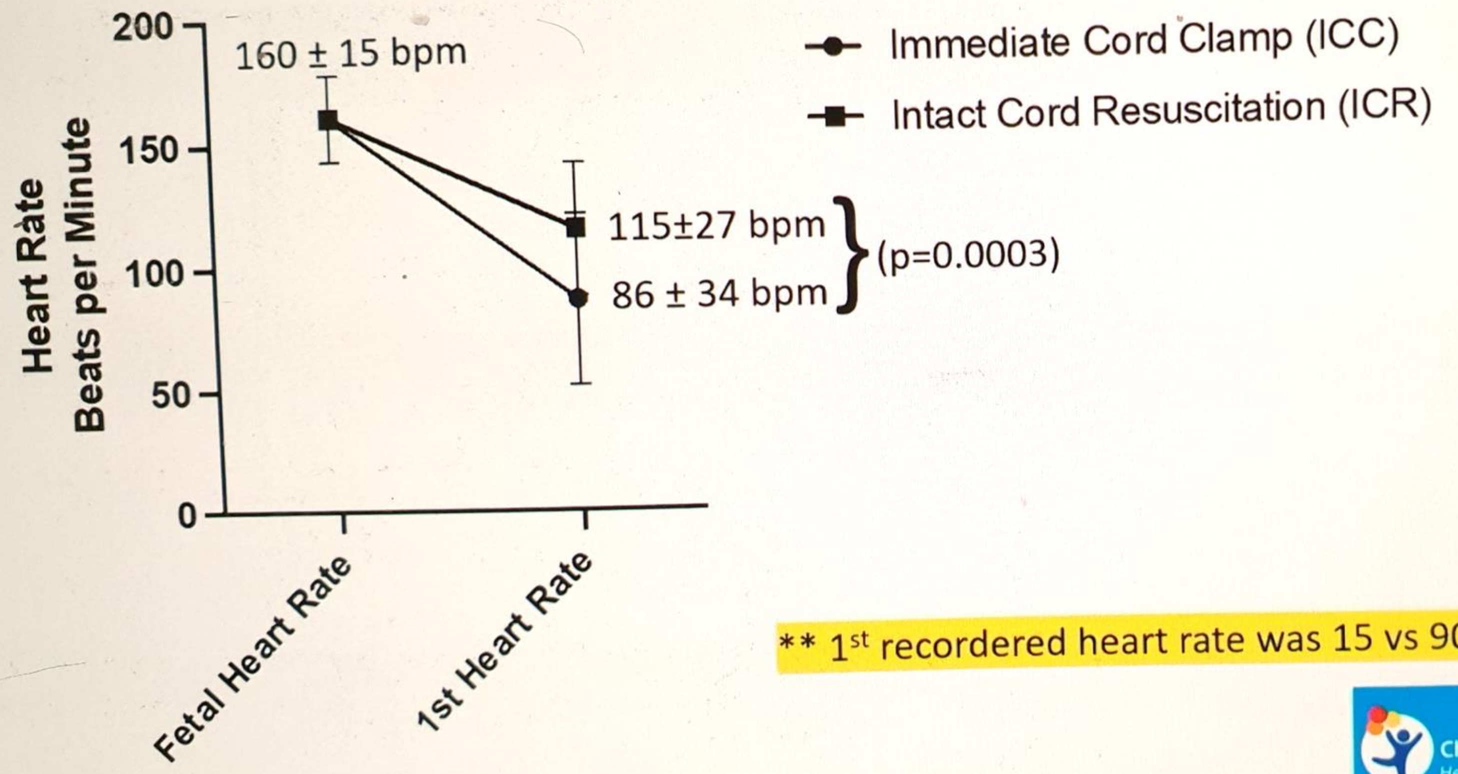
Demographics Intact Cord Resuscitation Versus Historical Controls

Characteristic	All (n=71)	Control (n=46)	Intervention (n=25)	P Value
Gestational Age.at.birth	37±2	37±2	38±1	0.1205
Weight	2958±489	2918±476	3030±514	0.3735
Percent Predicted Lung Volume (PPLV) 24wks	21±8	21±9	21±6	0.8939
Total Lung Volume (TLV)	31±13	30±12	32±15	0.6408
Lung Head Ratio (LHR)	1±1	1±0	1±1	0.1354
Observed:Expected LHR	45±17	44±17	46±16	0.6023
Liver				0.3773
Down	25 (35%)	14 (30%)	11 (44%)	
Up	46 (65%)	32 (70%)	14 (56%)	
APGAR.1	5±2	5±2	5±2	0.448
APGAR.5	7±2	7±2	7±1	0.3075
Closure				0.3143
Primary	28 (39%)	15 (33%)	13 (52%)	
Flap	35 (49%)	25 (54%)	10 (40%)	
Patch	8 (11%)	6 (13%)	2 (8%)	

Children's Hospital Colorado
Here, it's different.

School of Medici

Intact Cord Resuscitation Attenuates the abrupt Onset of Bradycardia with Umbilical Cord Clamping



** 1st recordered heart rate was 15 vs 90 seconds (Neobeat vs Pulse Oximetry)

Children's Hospital Colorado
Here, it's different.
School of Medicine

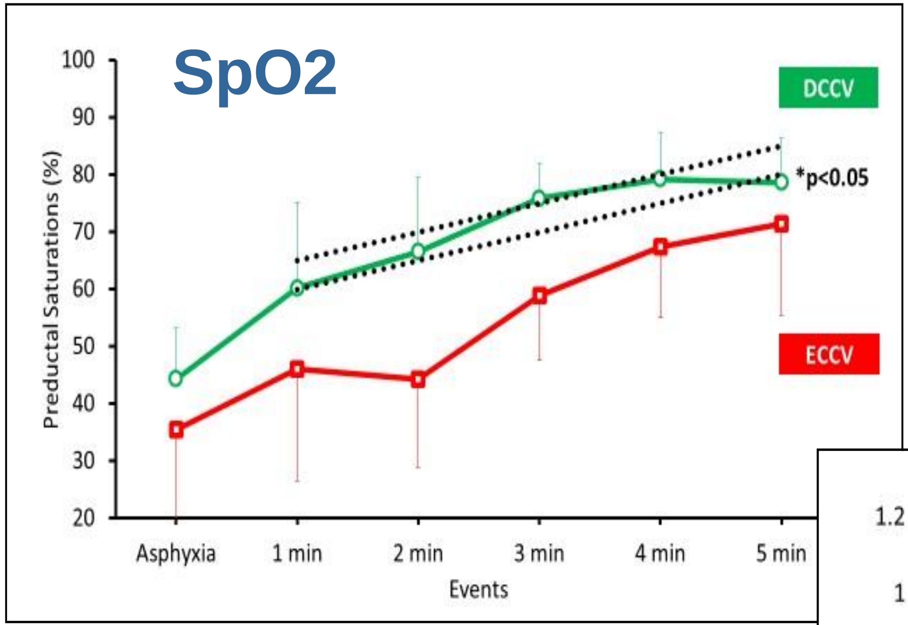
Echocardiographic Parameters Intact Cord Resuscitation Versus Historical Controls

	All (n=71)	Control (n=46)	Intervention (n=25)	
LV function				0.0234
Normal	43 (61%)	31 (67%)	12 (48%)	
Mild	6 (8%)	1 (2%)	5 (20%)	
Moderate	13 (18%)	10 (22%)	3 (12%)	
Severe	9 (13%)	4 (9%)	5 (20%)	
LV SF	35±13	35±13	34±15	0.8783
LF EF	64±19	67±16	60±22	0.2581
RV function				0.028
Normal	35 (49%)	27 (59%)	8 (32%)	
Mild	21 (30%)	9 (20%)	12 (48%)	
Moderate	12 (17%)	9 (20%)	3 (12%)	
Severe	3 (4%)	1 (2%)	2 (8%)	
TR jet	55±13	56±11	53±17	0.6277
PDA				0.7215
Bidirectional	52 (73%)	32 (70%)	20 (80%)	
Right to Left	18 (25%)	13 (28%)	5 (20%)	
Left to Right	1 (1%)	1 (2%)	0 (0%)	
PFO				0.8929
Bidirectional	26 (37%)	16 (35%)	10 (40%)	
Right to Left	11 (15%)	8 (17%)	3 (12%)	
Left to Right	34 (48%)	22 (48%)	12 (48%)	

Conclusion

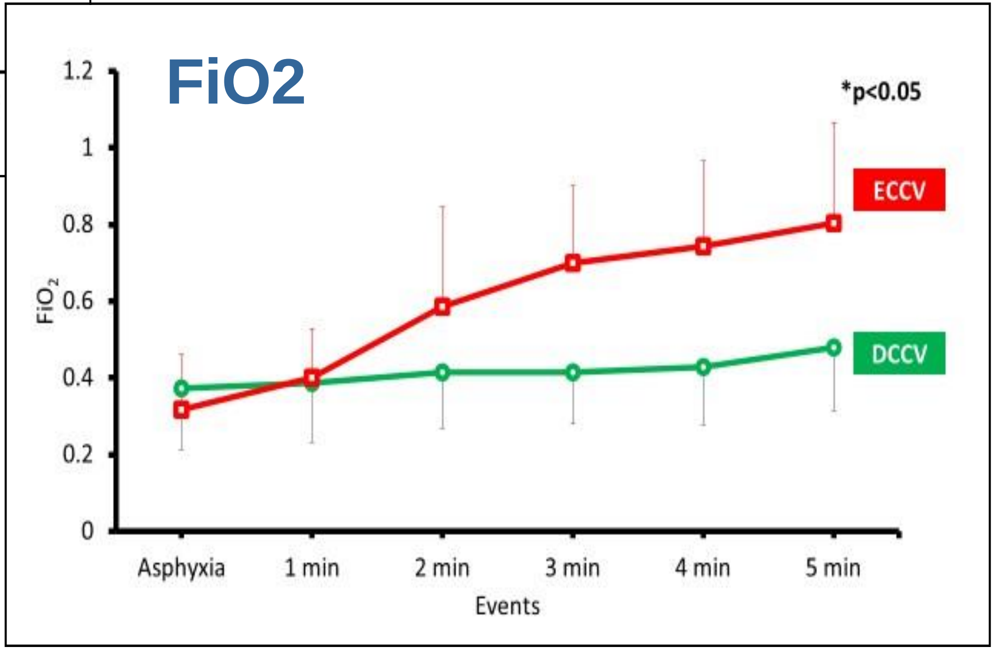
- Intact Cord Resuscitation in Infants with CDH
  - attenuates bradycardia that ensues after cutting the umbilical cord
  - no effect on cardiac function – possible detrimental effect in the most severe subset of infants
    - ➢LVEF 67.7% vs 30.5%
    - ➢LVSF 33% vs 6%
    - ➢2 patients in intervention group with retrograde flow in Ao Arch
- These differences were not apparent in the mild and moderate subsets
- No Difference in ECMO utilization, overall 29/71 (41%), controls 17/46 (37%), intervention 12/25 (48%) (p=0.5148)
- No difference in survival 9/71 (87%), %), controls 39/46 (85%), intervention 23/25 (92%) (p=0.4779)

Evolution de la SpO2 préductale lors d'une réanimation à cordon intact comparé à un clampage immédiat du cordon après un épisode d'asphyxie (agneau prématuré)



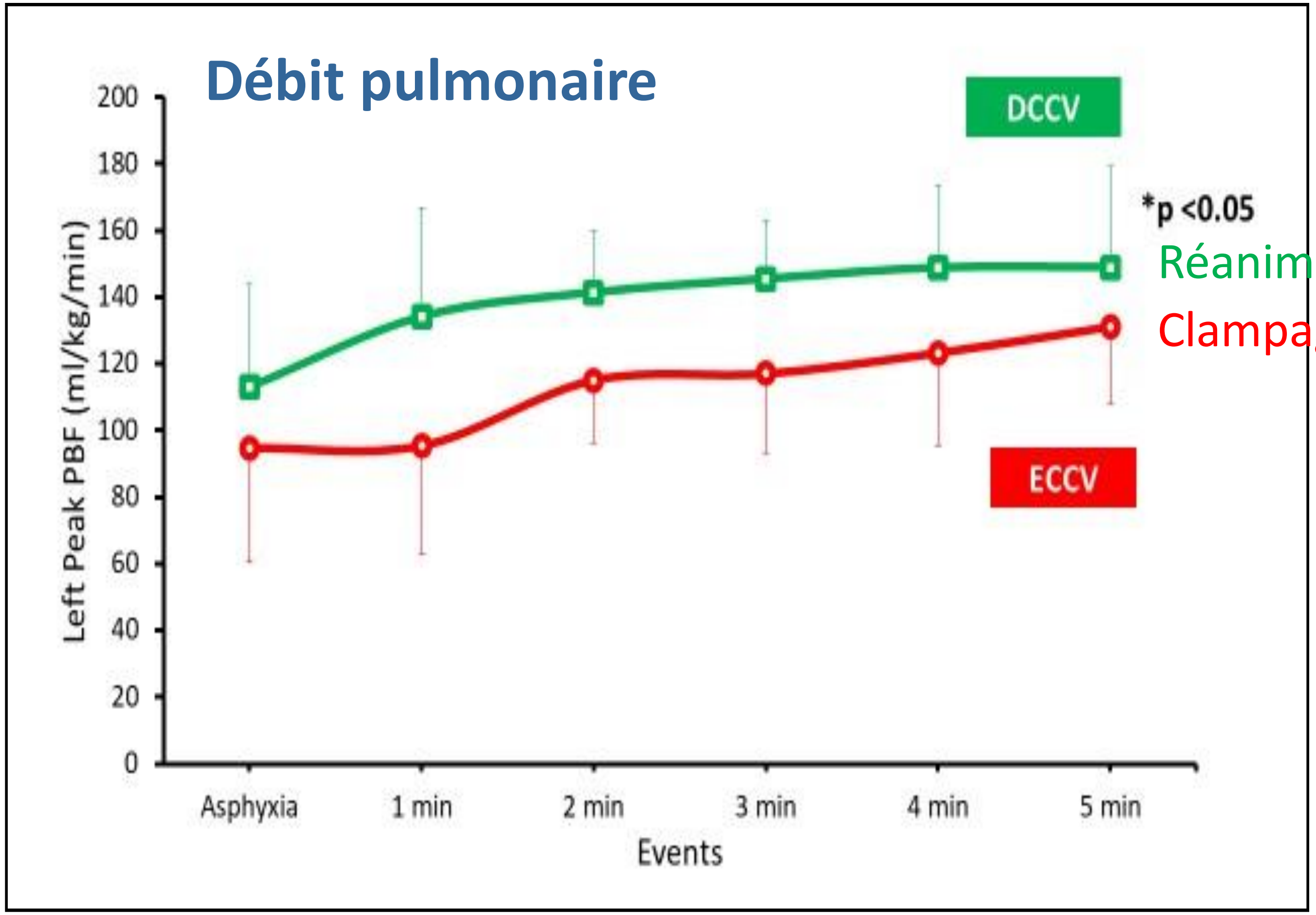
Réanimation à cordon intact

Clampage immédiat du cordon



Chandrasekharan, Children 2021

Evolution du débit pulmonaire lors d'une réanimation à cordon intact comparé à un clampage immédiat du cordon après un épisode d'asphyxie (agneau prématuré)

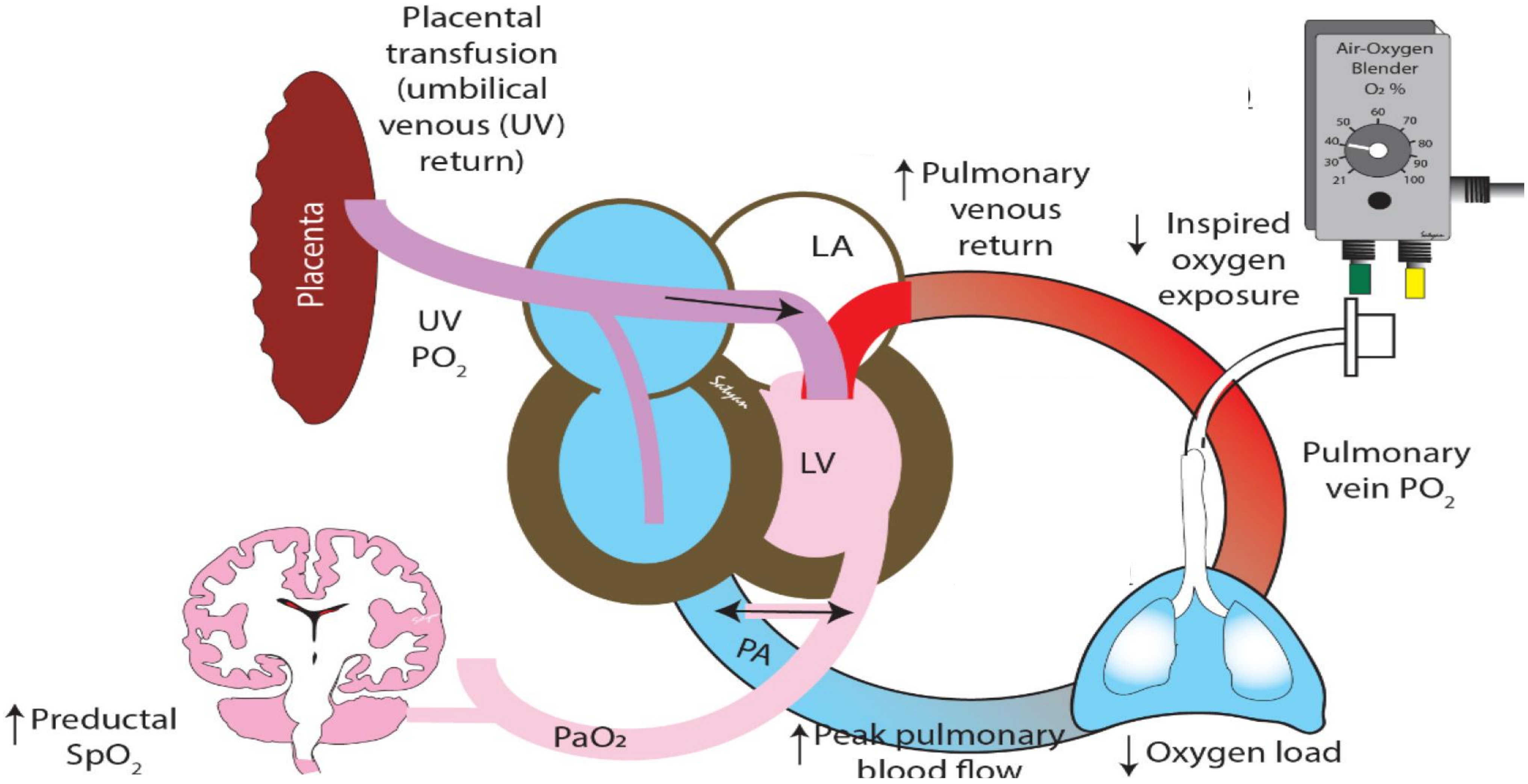


Réanimation à cordon intact

Clampage immédiat du cordon

Chandrasekharan, Children 2021

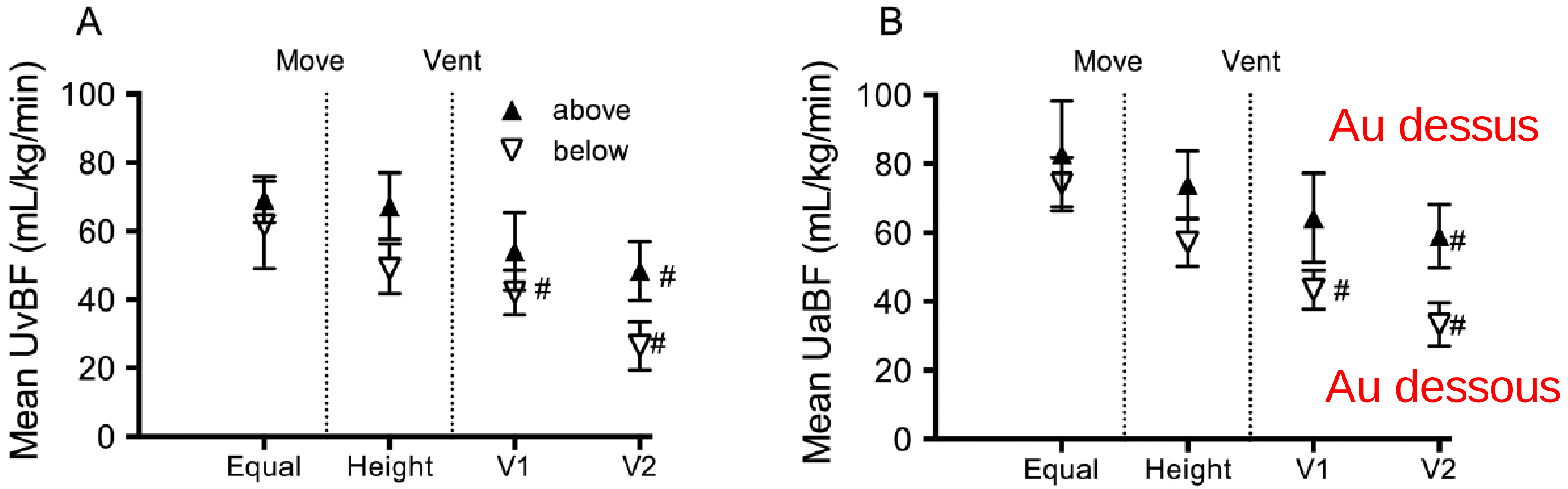
Chandrasekharan, Children 2021



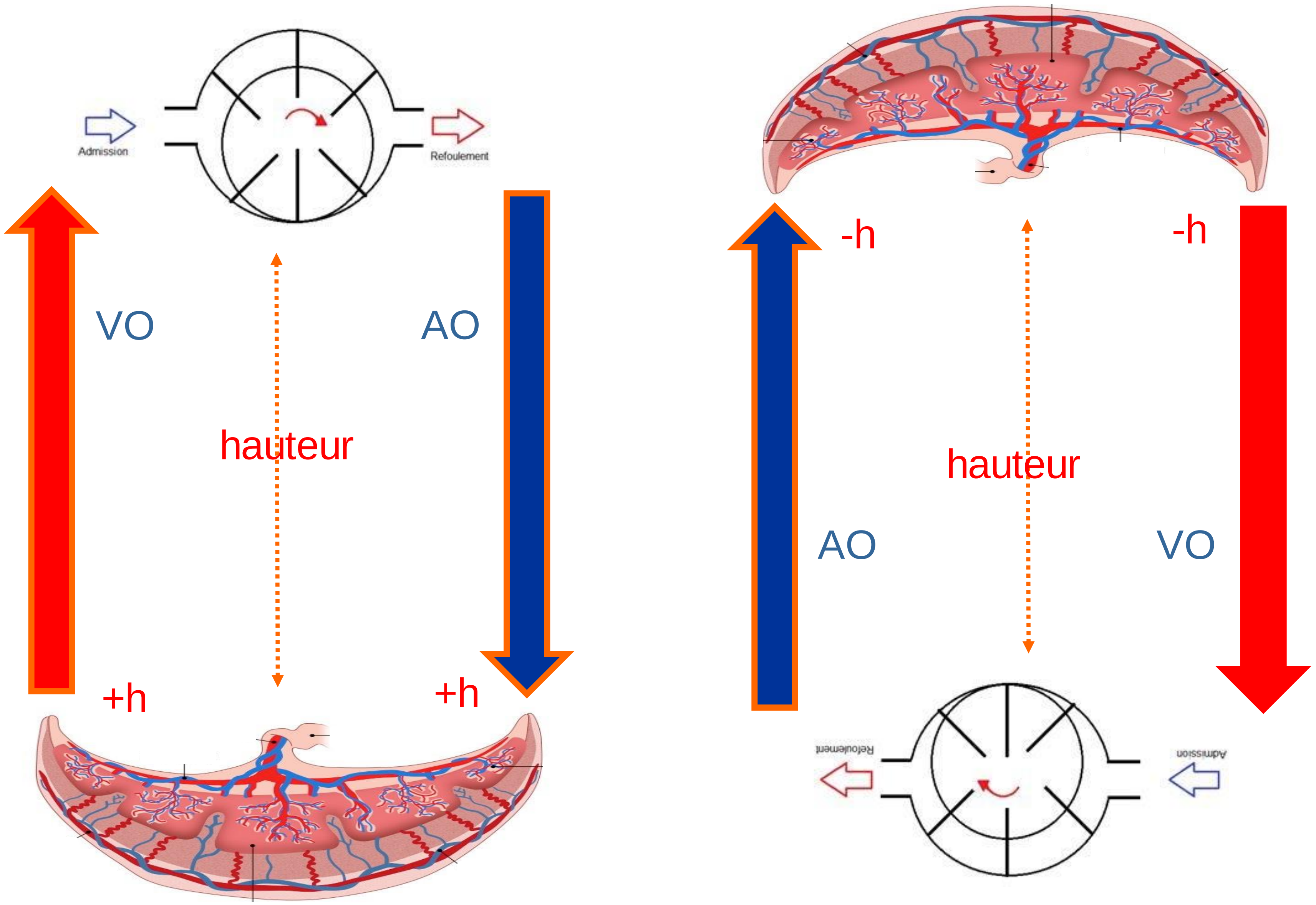
Oxygénation et circulation lors de la réanimation à cordon intact

Déterminants des débits ombilico-placentaires au cours de l'ICR

- **Comparaison des débits ombilicaux en fonction de la position du nouveau-né**

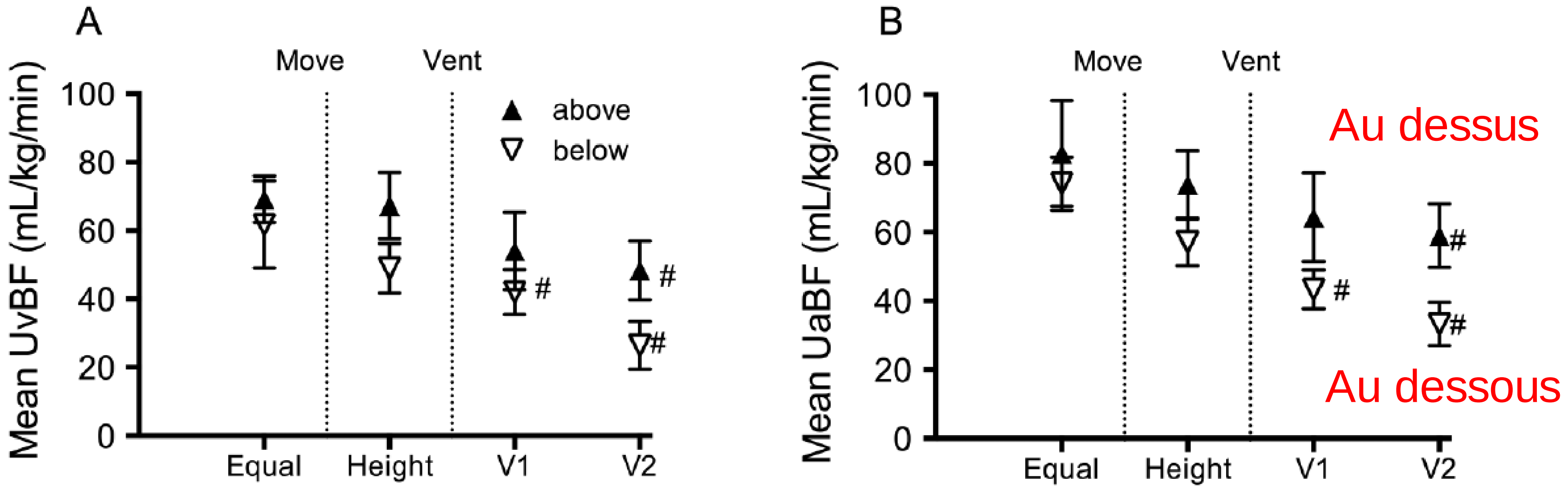


Hooper, Arch Dis Child Fetal Ed 2017


Admission
Refoulement
VO
AO
hauteur
+h
+h
-h
-h
hauteur
AO
VO

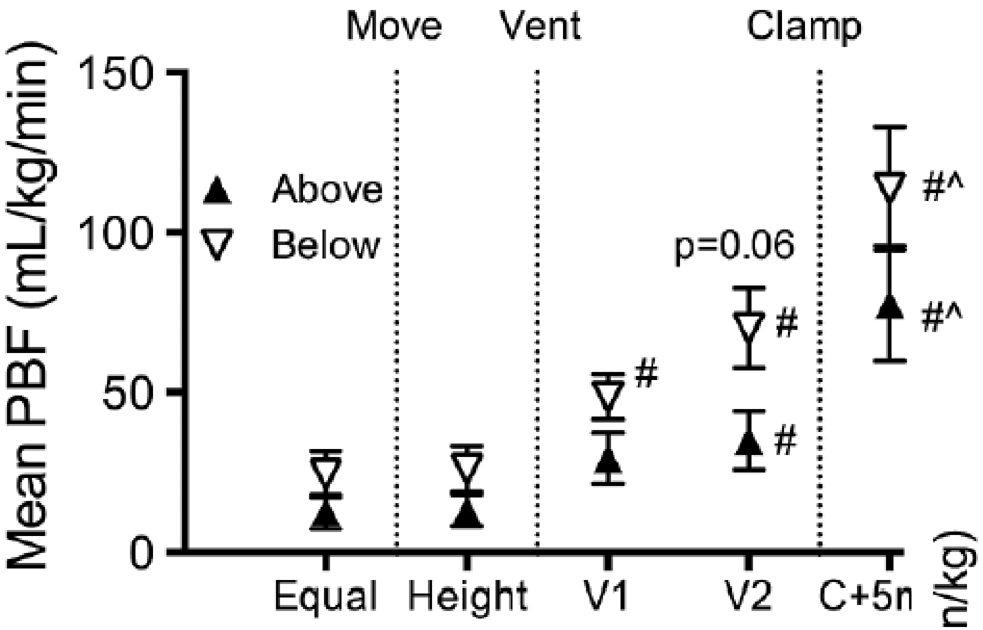
Déterminants des débits ombilico-placentaires au cours de l'ICR

- **Comparaison des débits ombilicaux en fonction de la position du nouveau-né**



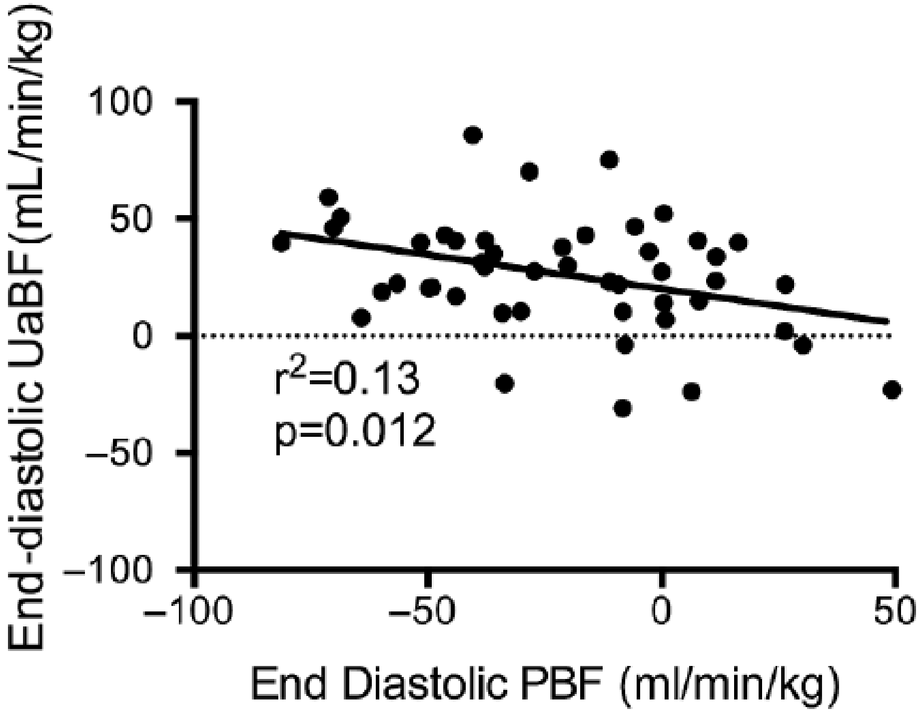
Hooper, Arch Dis Child Fetal Ed 2017

Comparaison des débits ombilicaux en fonction de la position du nouveau-né



Au dessous

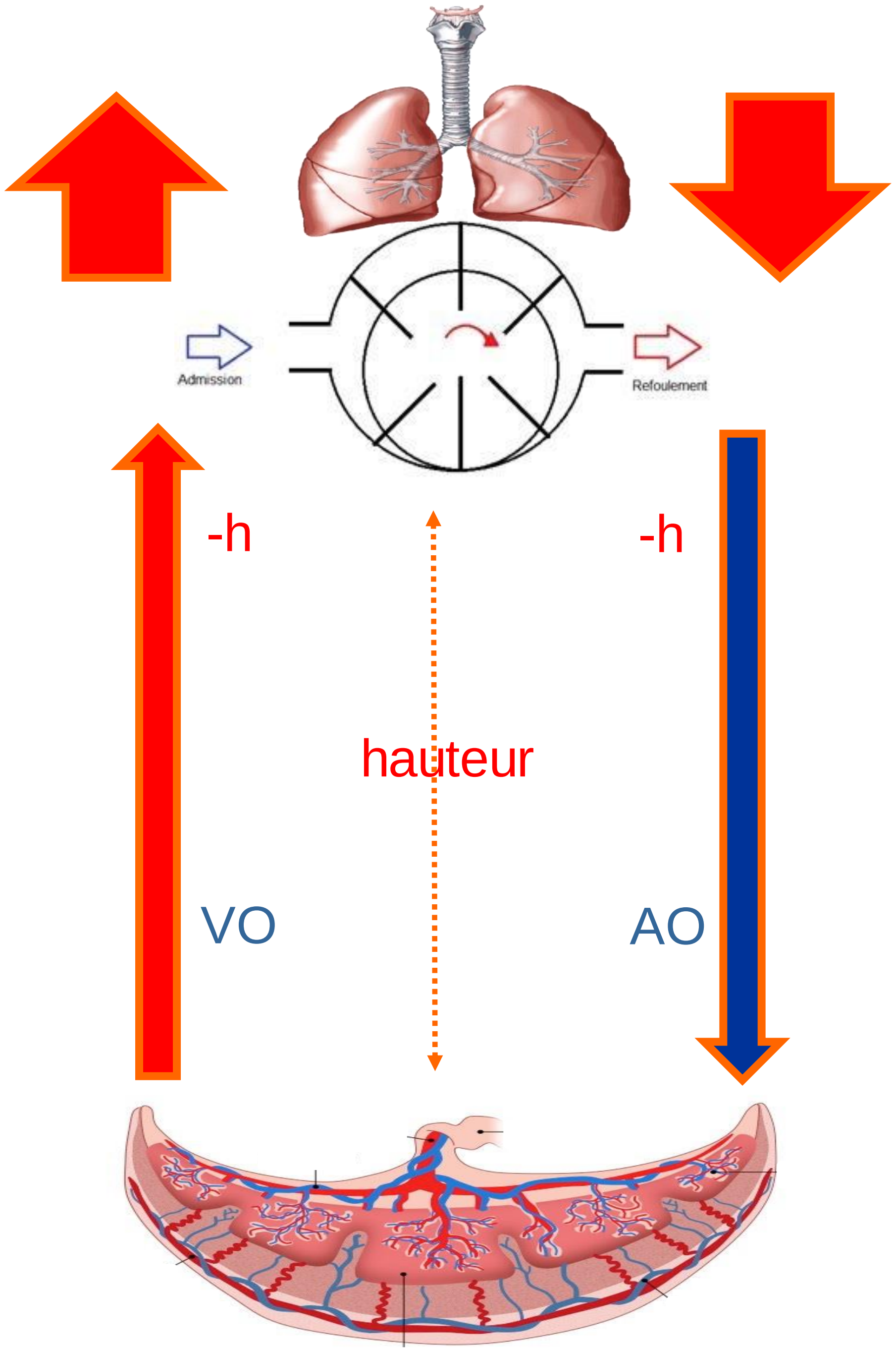
Au dessus

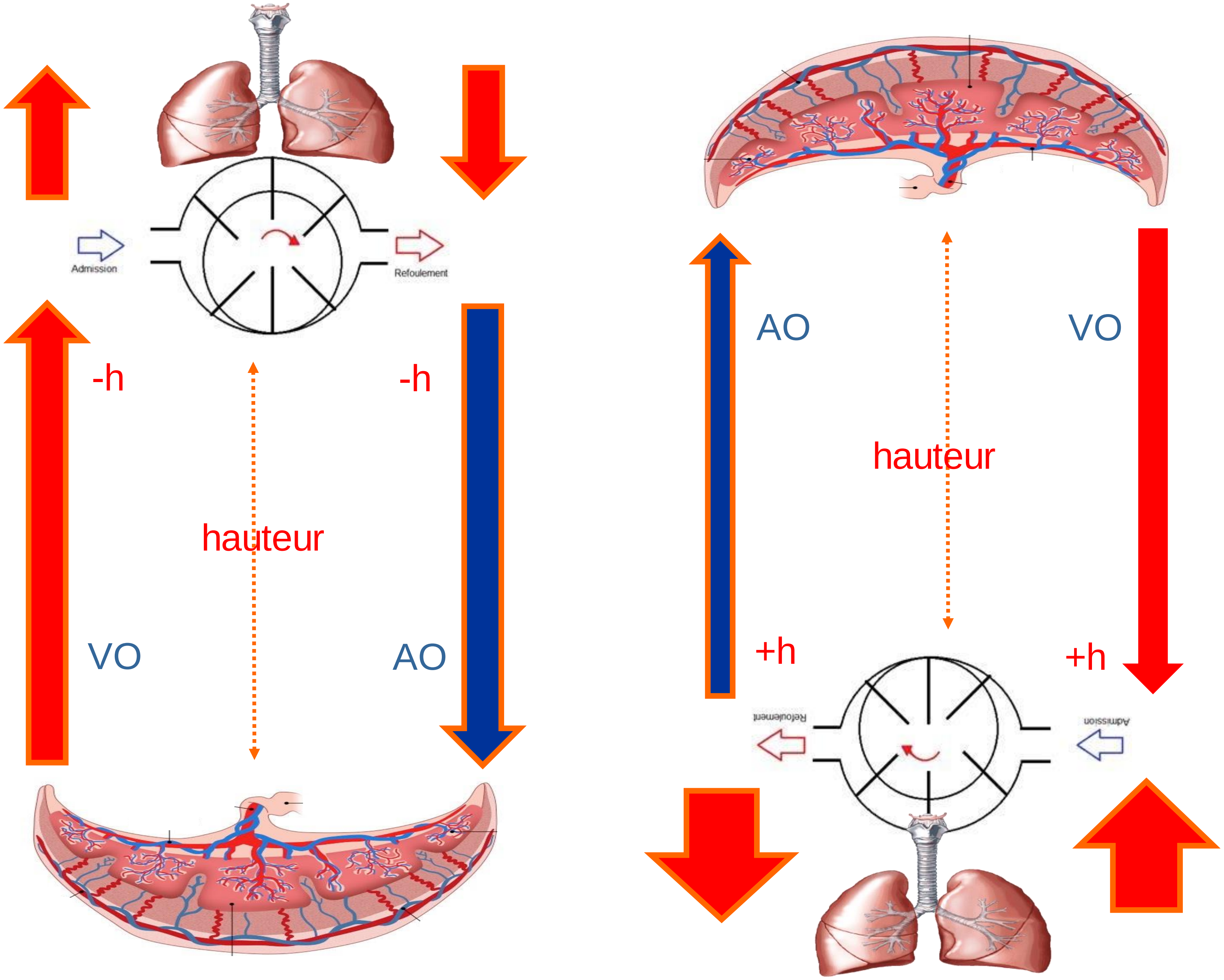


Hooper, Arch Dis Child Fetal Ed 2017

↑ débits pulmonaires

↓ perfusion placentaire





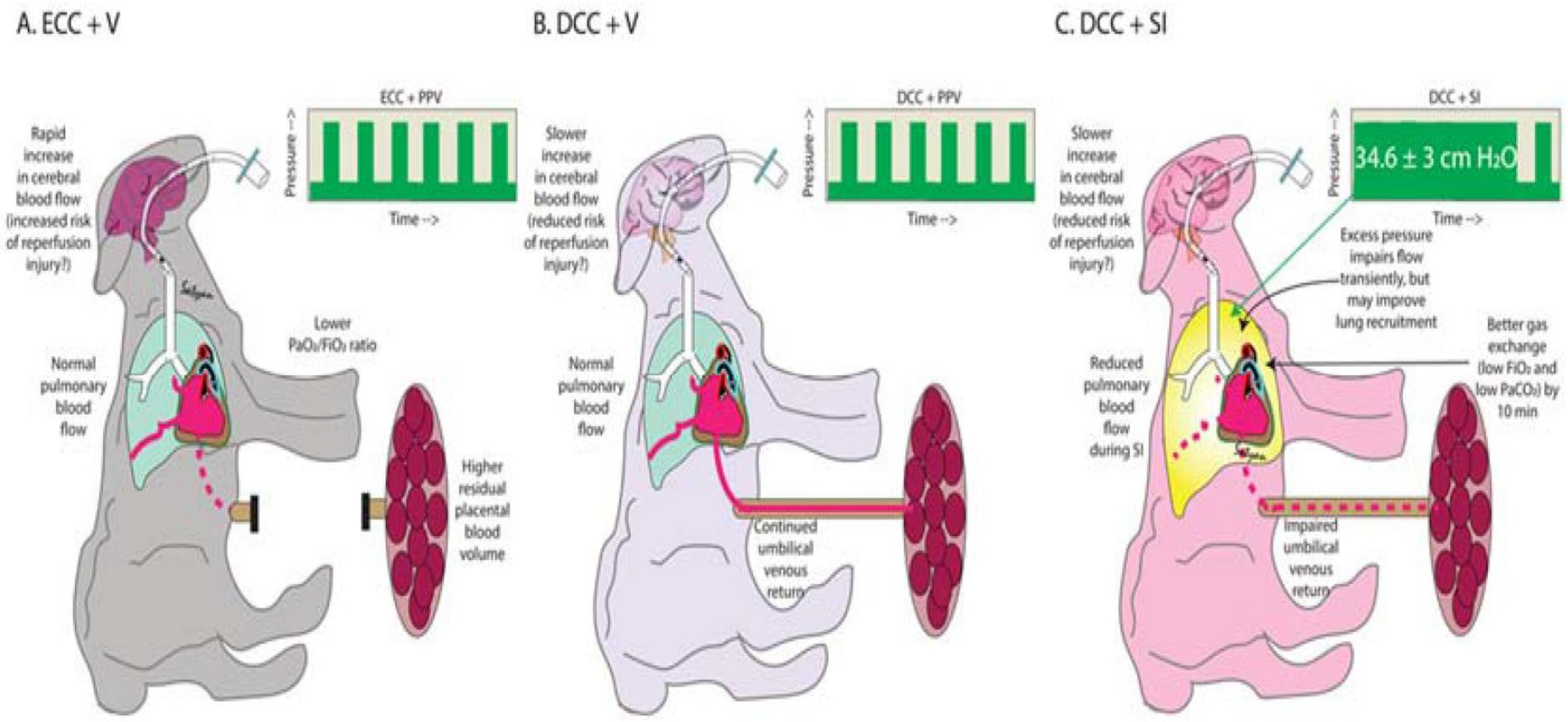
Admission
Refoulement
-h
-h
hauteur
VO
AO
AO
VO
hauteur
+h
+h
Refoulement
Admission

Comparaison des débits ombilicaux en fonction de la position du nouveau-né

- **Rapport volume sang Agneau/(Agneau+placenta) similaire dans les 2 groupes (60%)**

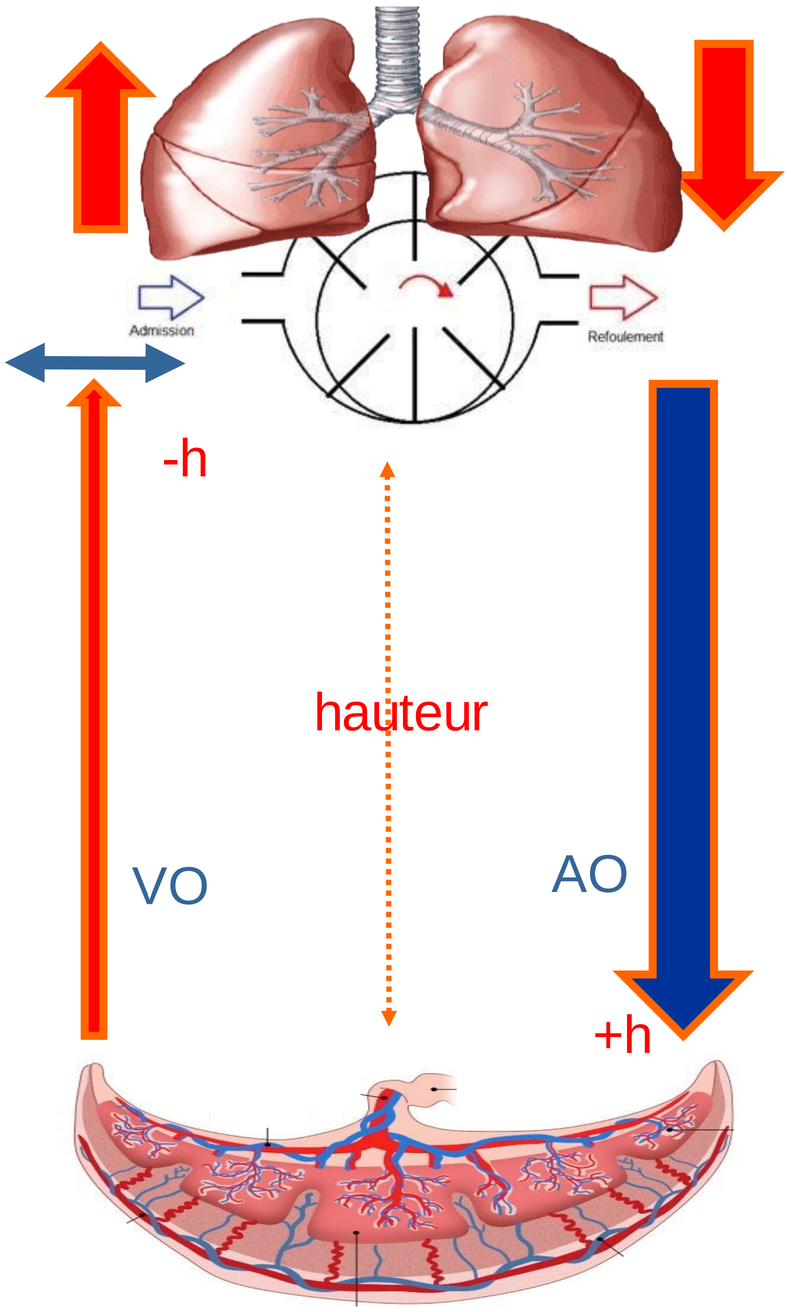
Hooper, Arch Dis Child Fetal Ed 2017

Pression de distension pulmonaire à la naissance réduit le débit veineux ombilical

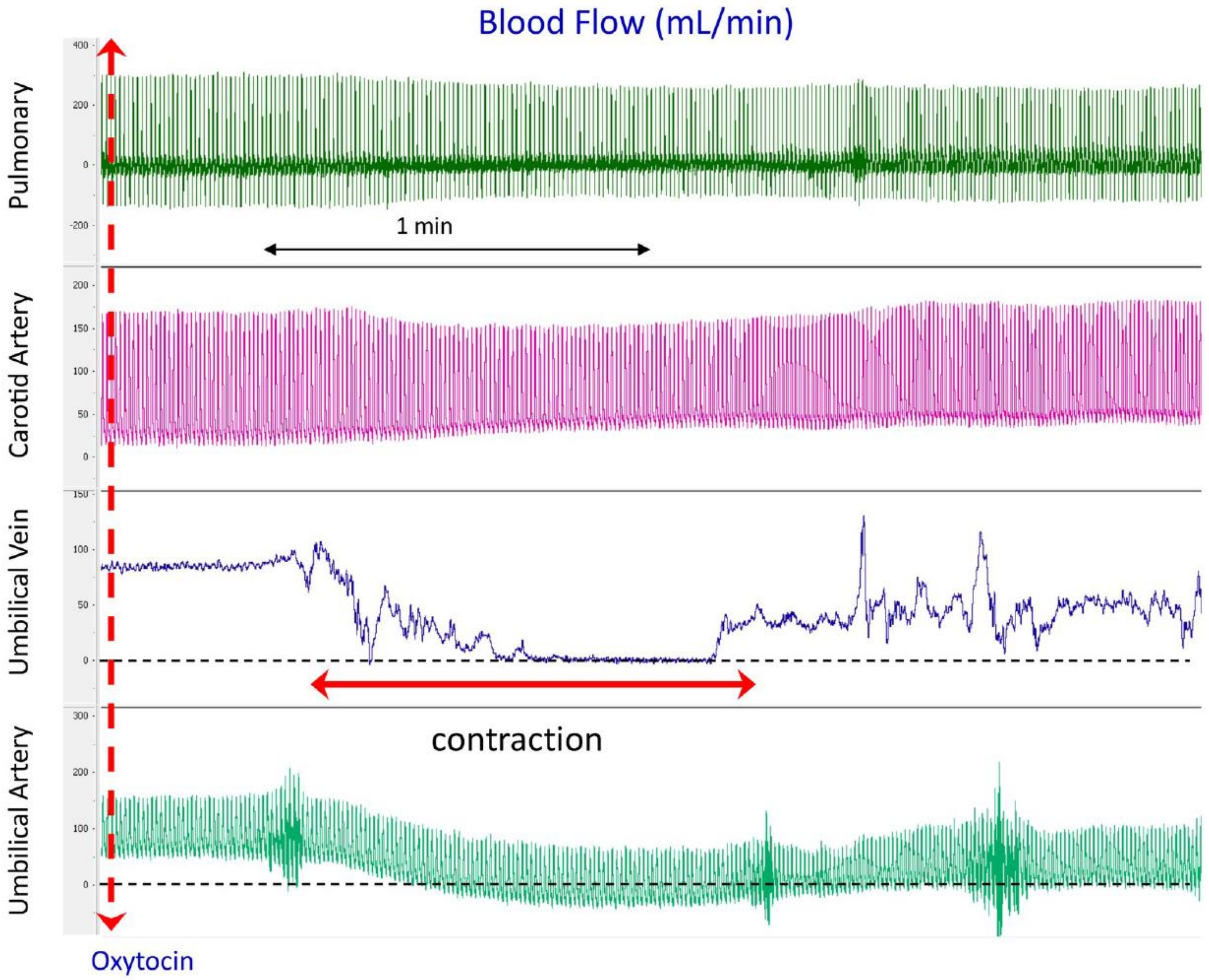


Nair, Children 2021

Distension pulmonaire

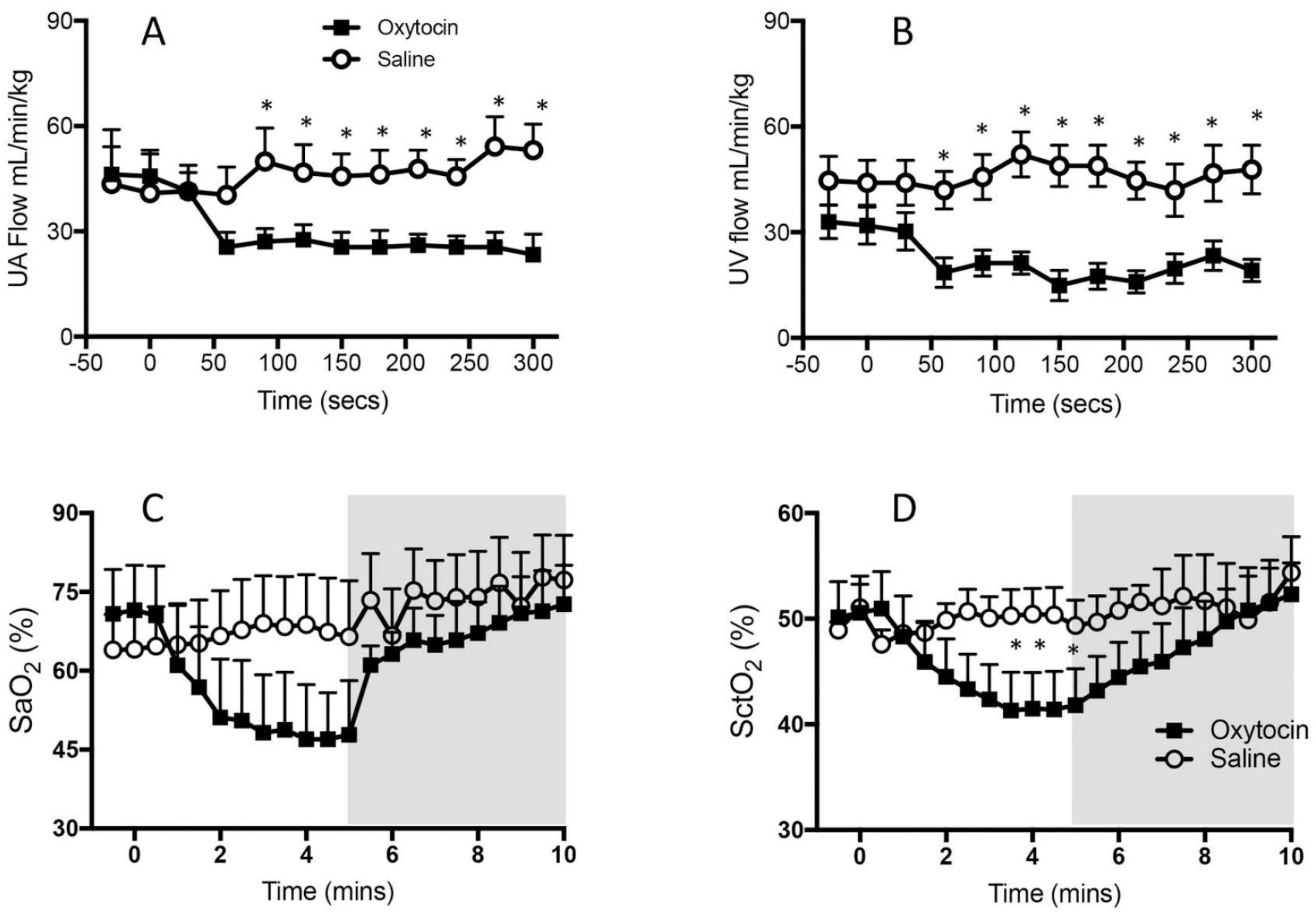


Effets de l'administration d'ocytocine



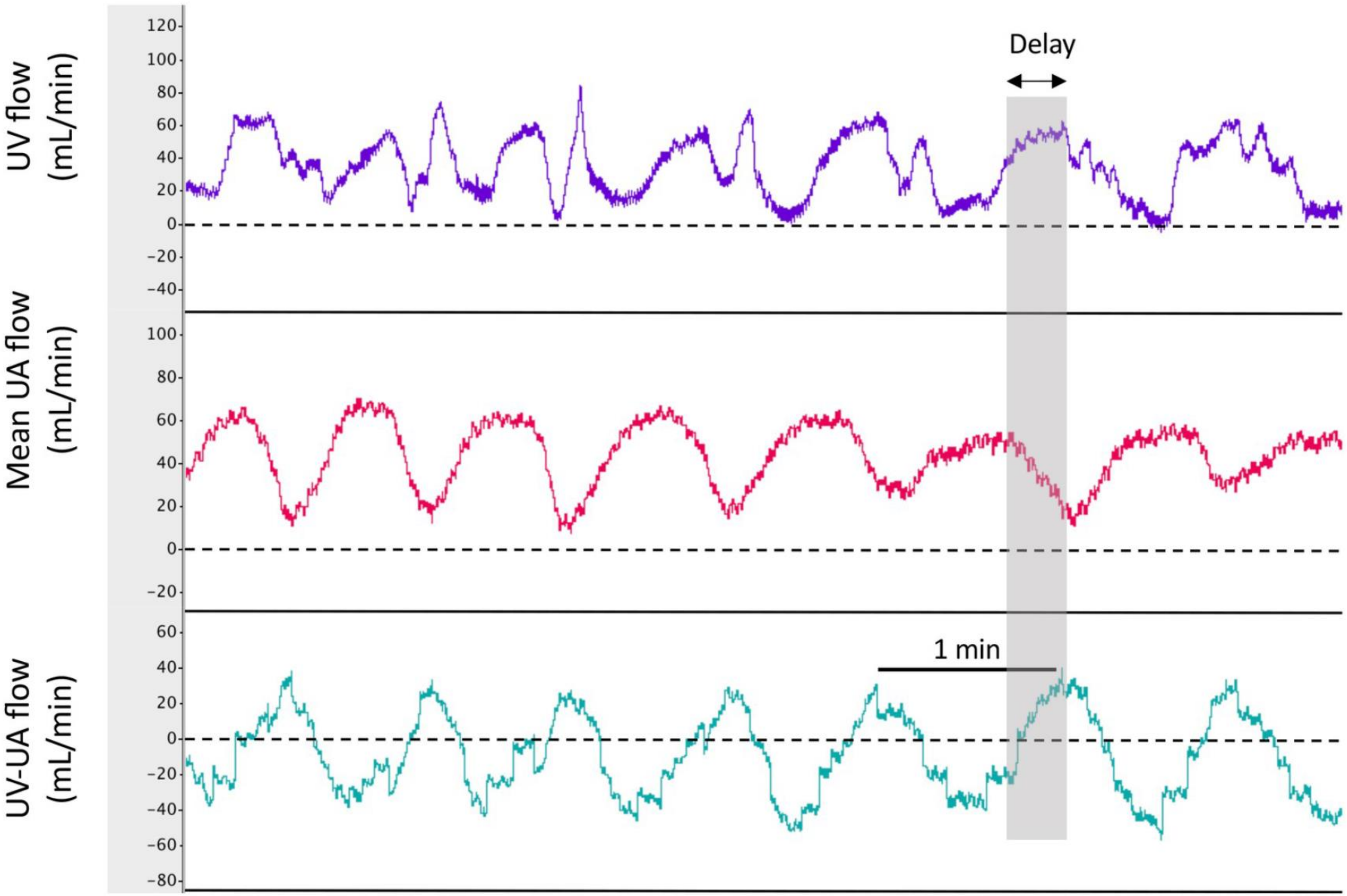
Stenning, Plos One 2021

Effets de l'administration d'ocytocine



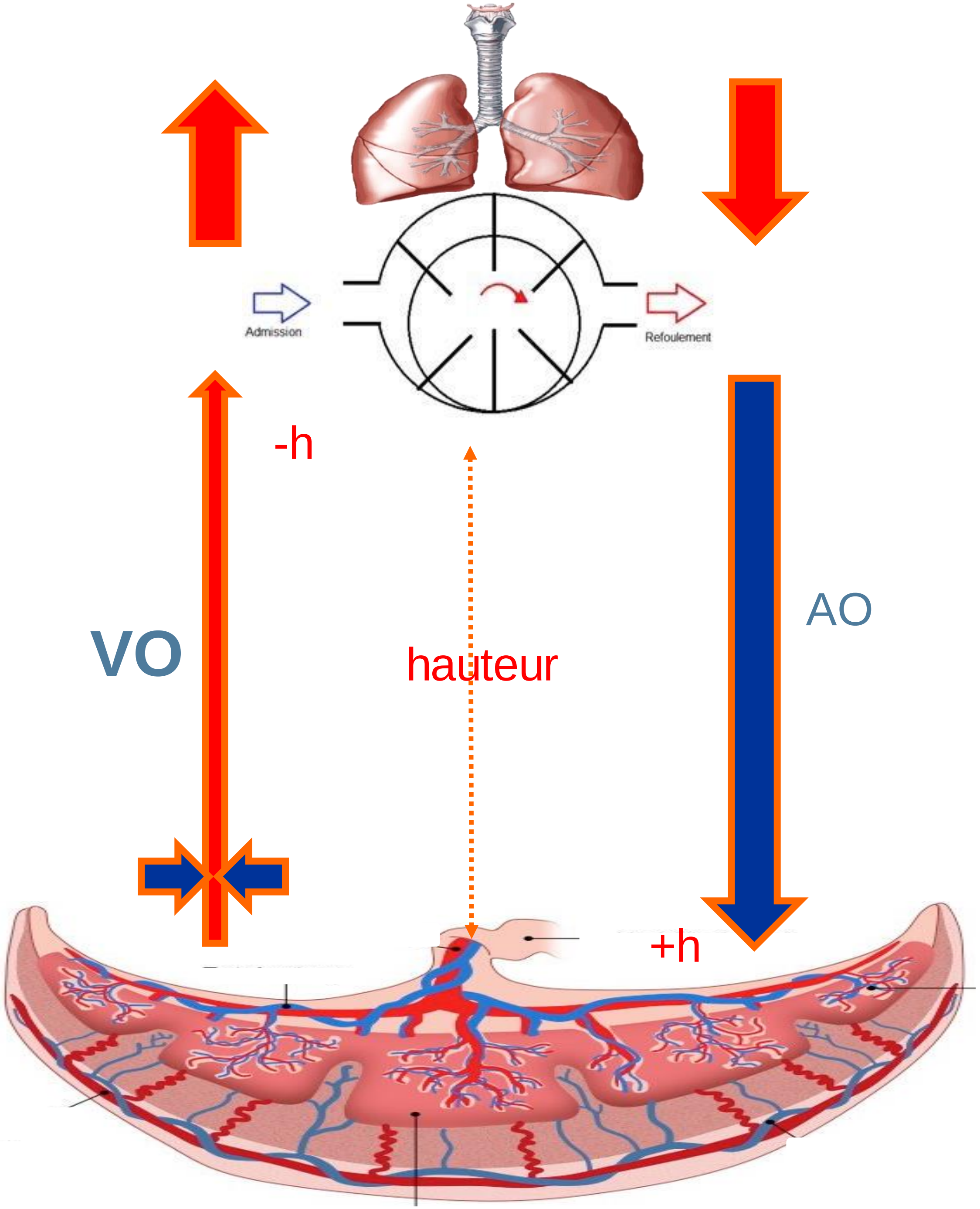
Stenning, Plos One 2021

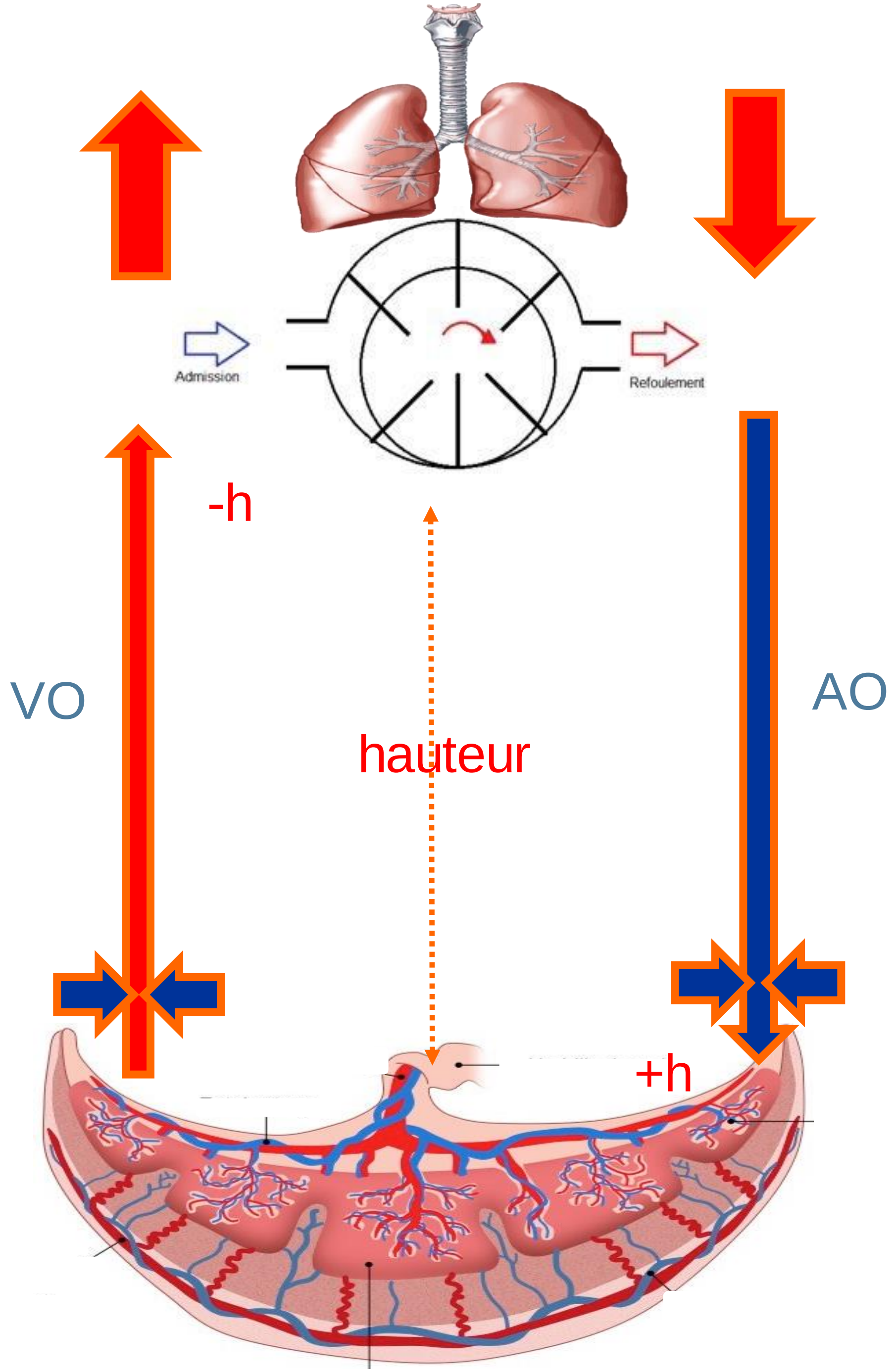
Effets de l'administration d'ocytocine



Stenning, Plos One 2021

Début de contraction utérine





Contraction utérine

ents Ltd

murdoch children's research institute

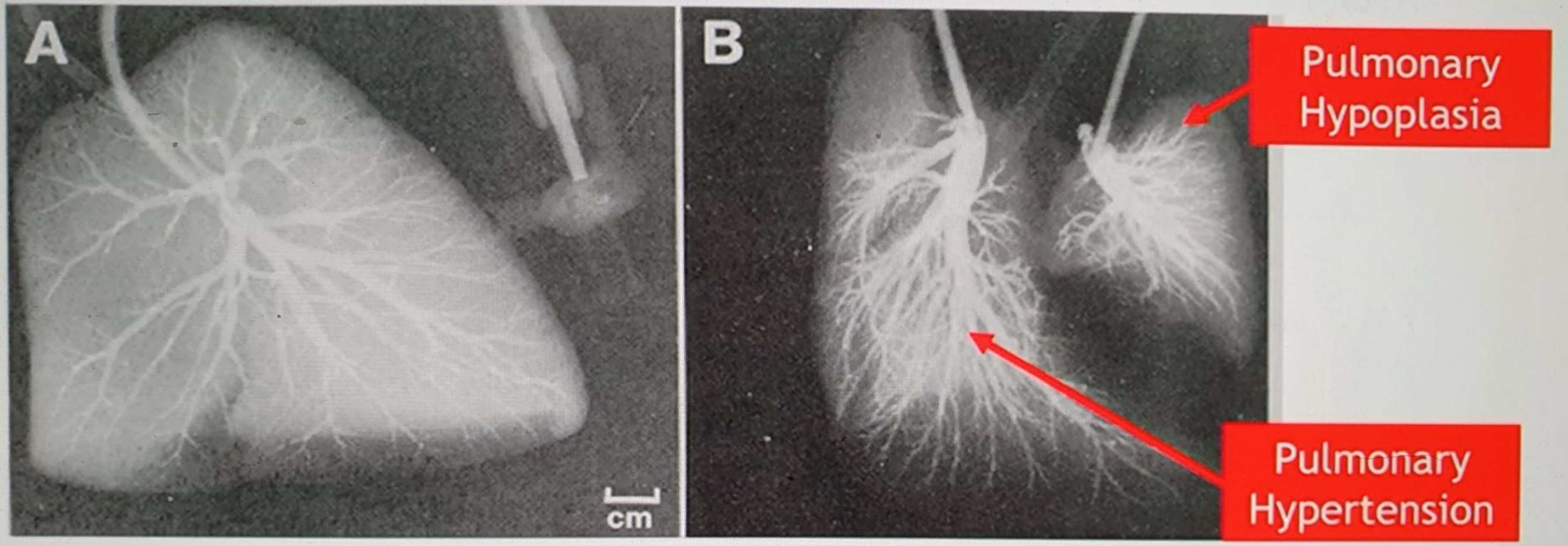
Respiratory Management in CDH: Do we still ~~have~~ *need* the answers?

David Tingay

1. Neonatal Research, Murdoch Children's Research Institute, Melbourne
2. Neonatology, Royal Children's Hospital
3. Dept of Paediatrics, University of Melbourne

Melbourne Children's
Excellence in clinical care, research and education

The Lung in CDH



Loss of lung unity

Levin *J Pediatr* 1978

Ltd

Pulmonary Hypoplasia
An exercise in compromise, patience and trust

- Small Lungs - less alveolar surface for gas exchange
- Increased VQ mismatching
- Unknown FRC and EILV

Biotrauma
Oxidative Injury

Managing Pulmonary Hypoplasia Current Guidelines

CDH Euro Consortium 2015

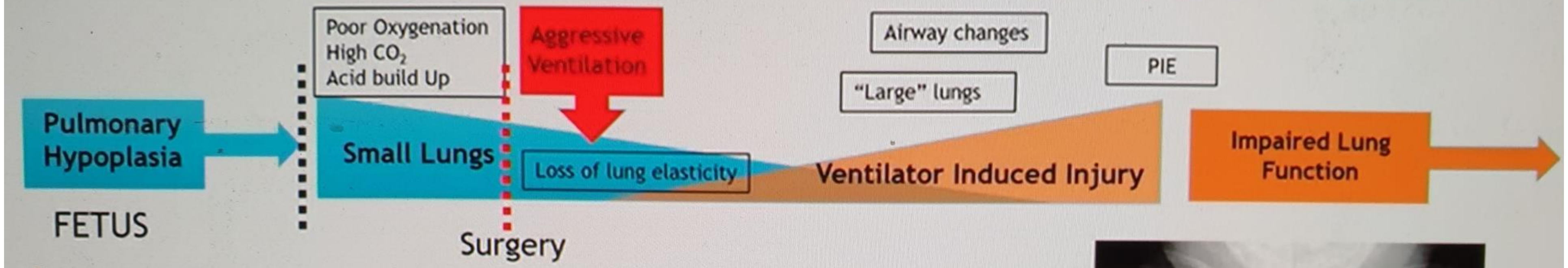
- Avoid BM Ventilation
- Decompress stomach
- CMV initial mode of support
  - PIP <25 cmH_2O
  - PEEP 3-5 cmH_2O
  - Rate 40-60/min
- HFOV rescue therapy (MAP >12 cmH_2O)
- Preductal SpO_2 80-95% (Post SpO_2 >70%)
- $PaCO_2$ 50-70 mmHg

TABLE 1. OUTLINE OF PRINCIPLES OF MANAGEMENT

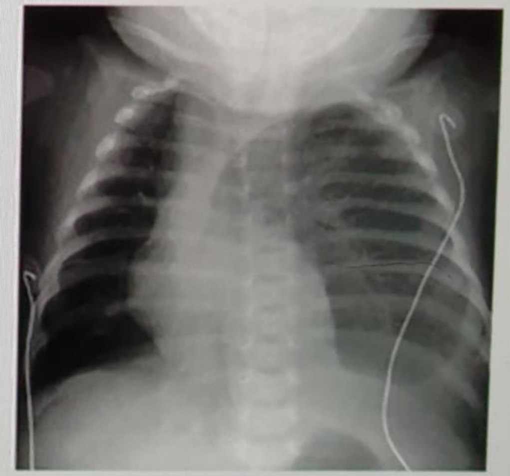
Resuscitation
ET tube placement with minimal bag mask/ventilation
Vascular access
Gut decompression by nasogastric tube
Ventilation objectives: preductal Sa_{O_2} > 85% and pH > 7.3 with PIP ≤ 25 cm H_2O
Cardiopulmonary management
Ventilation
Conventional ventilation
Objective: preductal Sa_{O_2} > 85% pH > 7.3
PIP ≤ 25 cm H_2O
HFOV
Objective: preductal Sa_{O_2} > 85%
MAP ≤ 16 cm H_2O
Pulmonary vascular management
Cardiac echo
Exclude CHD
Assess RV function
Estimate PA pressure
Identify the ductus and assess shunting
Trial of inhaled nitric oxide for patients with increased RV pressure

Bohn *AJRCCM* 2002; Snoek *Neo* 2016

Respiratory Management Phases of CDH



1. Birth: Initial slightly higher PEEP (never use SI)
2. Pre-repair: Lowest possible PEEP (3-6 cmH_2O)/MAP
3. Post-repair: Low PEEP (3-5 cmH_2O) overdistension risk/MAP
4. Titrating to pathophysiological priorities after surgery
   - Aim low initially but don't resist higher PEEP/MAP to support airway or interstitial changes later
   - Positioning



Tingay AJRCCM 2019; Guevorkian J Peds 2018; Wu Ann Palliat Med 2020

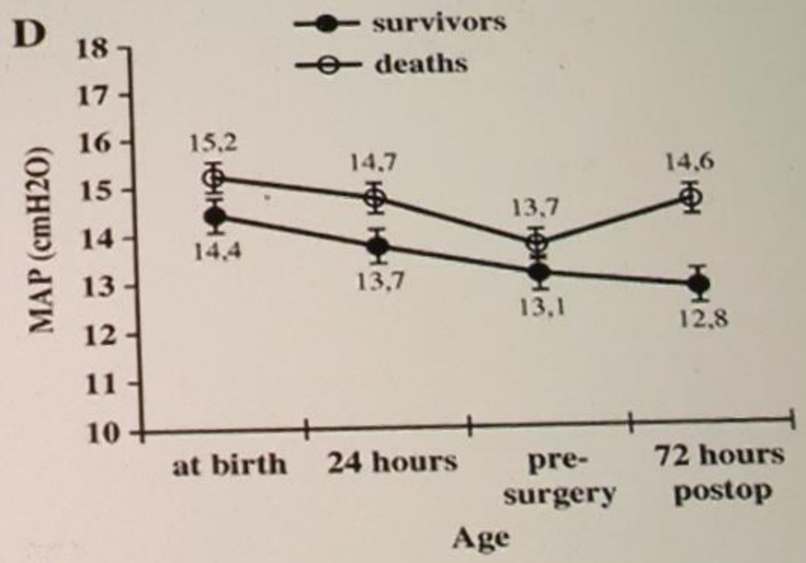
Not all CDH Lungs are the same
Is there Pulmonary Hypoplasia CDH Phenotypes?

Tidal Volume:

- 4.7 ml/kg (pre) and 4.5 ml/kg (post)

Associated with survival:

- V_{Texp} 4.3 vs 2.0 ml/kg
- V_{Texp} >3.8 ml/kg
- C_{dyn} >0.12 ml/kg/cmH_2O
- Higher Dead space
- Lower MAP needs
- Higher maximal pre-ductal SpO_2 in DR

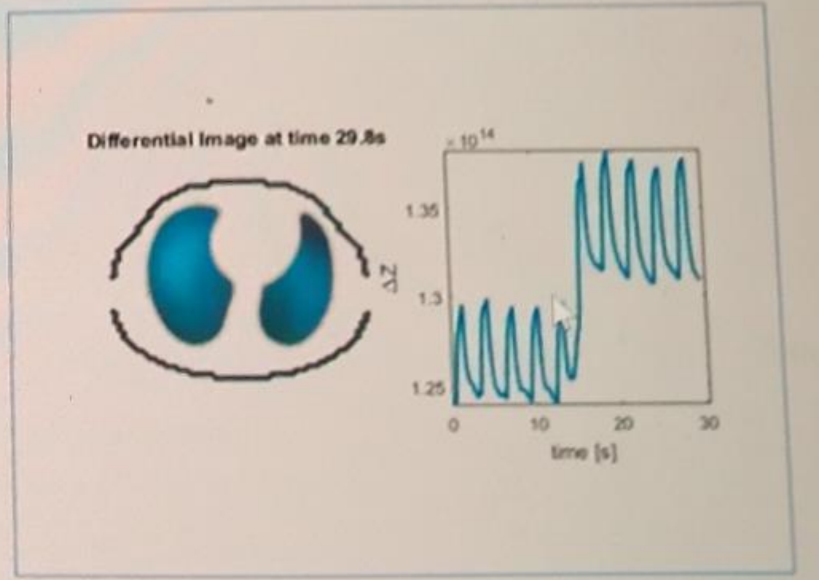


Are early measures of mechanical state the best discriminator of pulmonary hypoplasia, post-hypoplasia support and/or later VILI?

Mak *ADC FN* 2020; O'Rourke-Potocki *ADC* FN 2017; Williams *Early Human Dev* 2020; Migliazza *J Pediatr Surg* 2007

Do we really understand the CDH lung?
Volume state, Lung Function and Lung Disunity?

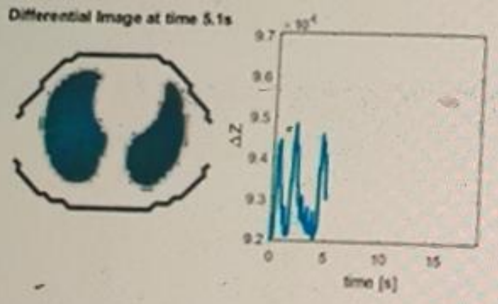
- All current bedside measures of lung function assume lung unity
- Electrical Impedance Tomography (EIT) assesses both lungs simultaneously

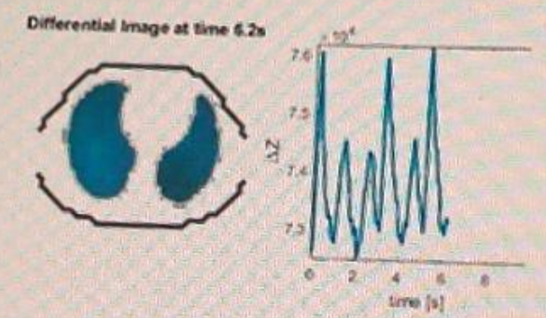


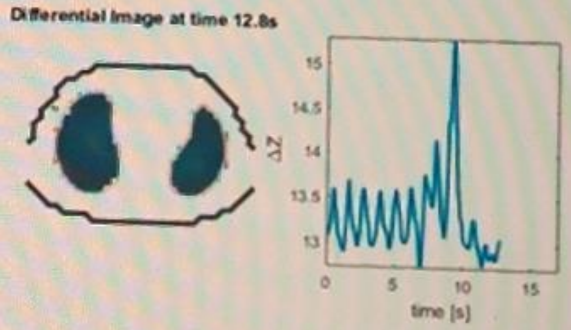
Withdrawal of ETT from RMB to trachea

Lung Behaviour during post-natal CDH life

- Serial EIT imaging at the RCH; n=18 infants







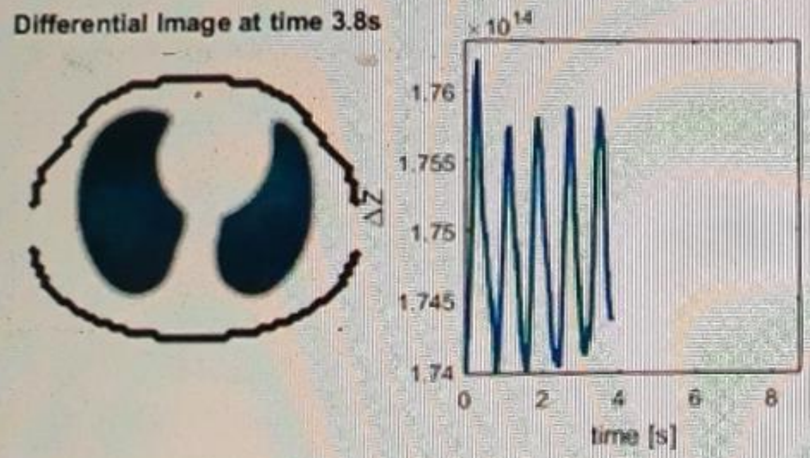
Pre-Repair	
Right Lung	97.3%
Left Lung	2.7%
CoV_{RL}	25.6%
CoV_{VD}	53.8%

D3 Post-Repair	
Right Lung	76.7%
Left Lung	23.3%
CoV_{RL}	36.9%
CoV_{VD}	56.3%

2 month age	
Right Lung	67.1%
Left Lung	32.9%
CoV_{RL}	41.8%
CoV_{VD}	56.8%

Idea CoV: RL 46%; VD 55%

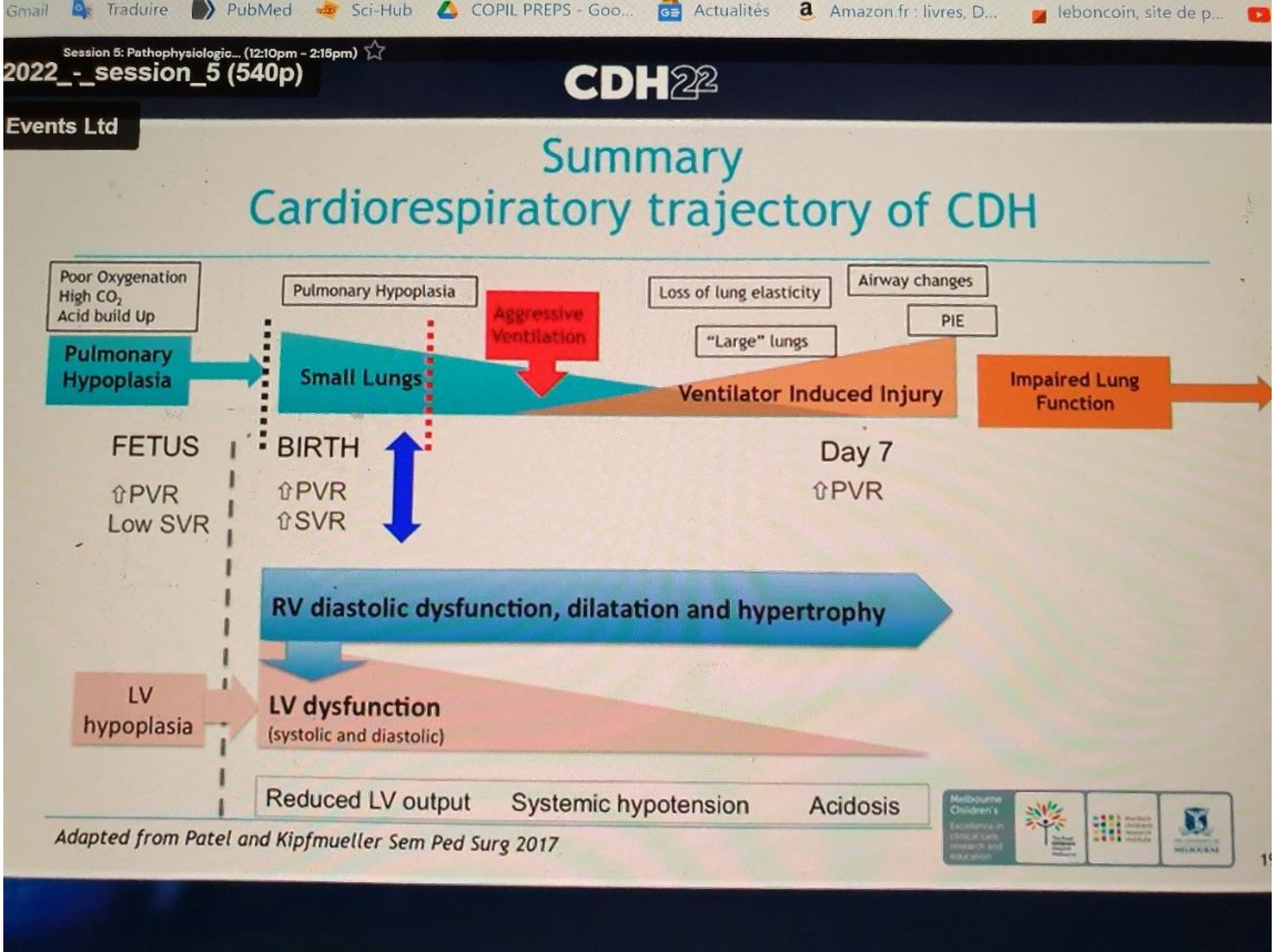
Defining the mechanical disunity of the CDH lung



Contralateral Lung τ = 0.067s

Ipsilateral Lung τ = 0.065s

Time to achieve steady state end-inspiratory volume
Contralateral = 0.335 s
Ipsilateral = 0.325 s



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Session 5: Pathophysiologic... (12:10pm - 2:15pm)
2022_-_session_5 (540p)
Events Ltd
CDH22
Summary
Cardiorespiratory trajectory of CDH
Poor Oxygenation
High CO_2
Acid build Up
Pulmonary Hypoplasia
Pulmonary Hypoplasia
Small Lungs
Aggressive Ventilation
Loss of lung elasticity
"Large" lungs
Airway changes
PIE
Ventilator Induced Injury
Impaired Lung Function
FETUS
⇧PVR
Low SVR
BIRTH
⇧PVR
⇧SVR
Day 7
⇧PVR
RV diastolic dysfunction, dilatation and hypertrophy
LV hypoplasia
LV dysfunction
(systolic and diastolic)
Reduced LV output
Systemic hypotension
Acidosis
Adapted from Patel and Kipfmueller Sem Ped Surg 2017
Melbourne Children's

CDH22

What matters to us: Personalising Support for people with CDH?

***

Philosophy of Care

*

Laurent STORME, Sébastien MUR, Dyuti SHARMA, Céline COUTTE, Kévin Le DUC, Nicoleta PANAIT, Alexandra BENACHI, For the National Center for Rare Disease « CDH»

*

Lille, Hôpital Jeanne de Flandre, CHRU de Lille

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*

Hernie de coupole diaphragmatique · maladies rares · European Reference Networks · Liberté • Égalité • Fraternité RÉPUBLIQUE FRANÇAISE MINISTÈRE DES AFFAIRES SOCIALES ET DE LA SANTÉ · DIRECTION GÉNÉRALE DE L'OFFRE DE SOINS · CHU LILLE · Université de Lille · FIMATHO maladies rares abdomino-thoraciques

Professionals vs families : What matters to us?

Mortality - Comorbidities

- Mortality : from 10 to 40%
- Comorbidities: from 40 to 60%
  - Chronic lung disease, Pulmonary hypertension;
  - Oral aversion, failure to thrive, growth retardation;
  - Scoliosis, pectus excavatum;

How can we better predict the outcome ?

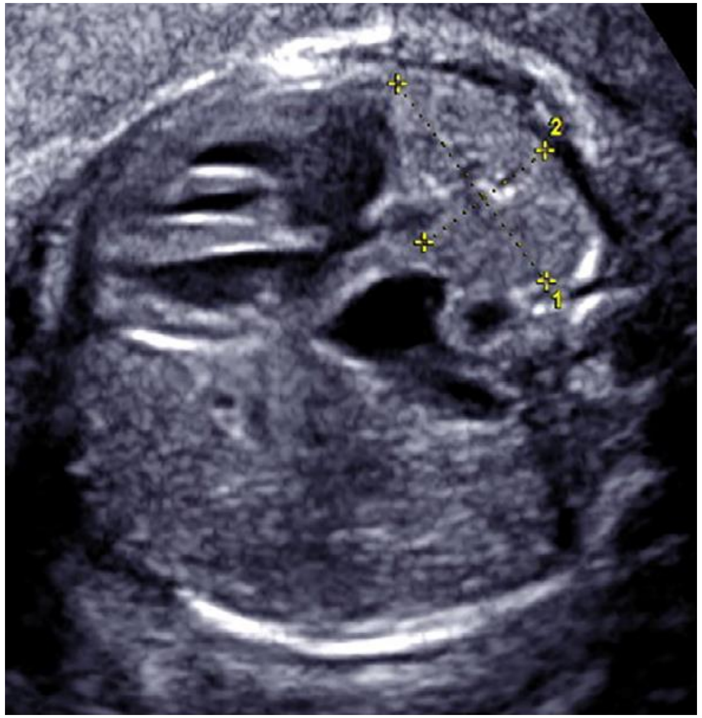
Prenatal prognostic factors

- Isolated CDH or syndromic CDH?
- Gestational age at birth ;
- Side of the CDH ;
- Severity of the pulmonary hypoplasia.

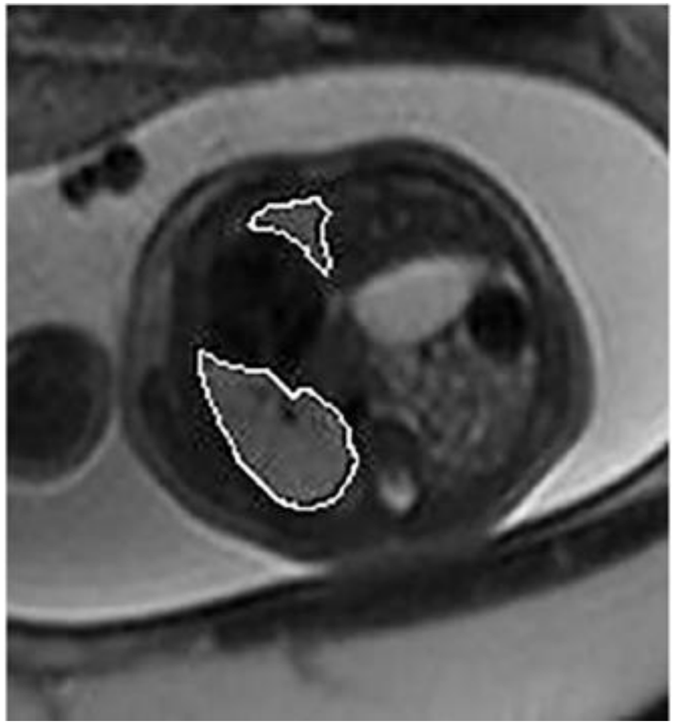
Severity of the pulmonary hypoplasia and of the pulmonary hypertension

Prenatal assessment of the lung volume:

Observed/expected « lung over head ratio »



MRI: O/E Fetal Lung volume



Observed/expected « Lung over head ratio »

Table 2 – Prognosis of Left CDH with liver UP correlates with LHR observed/expected measured at US evaluation.

Left CDH, liver UP	LHR o/e	Survival
Very severe	<15%	<5%
Severe	16–25%	20–30%
Moderate	26–45%	40–60%
Mild	>45%	95%

AG Cordier, Semin Perinatol 2020

Lung volume measured by MRI

Table 3 – Prognosis of Left CDH depending on liver position and TFLV (Total Fetal Lung Volume) by MRI.

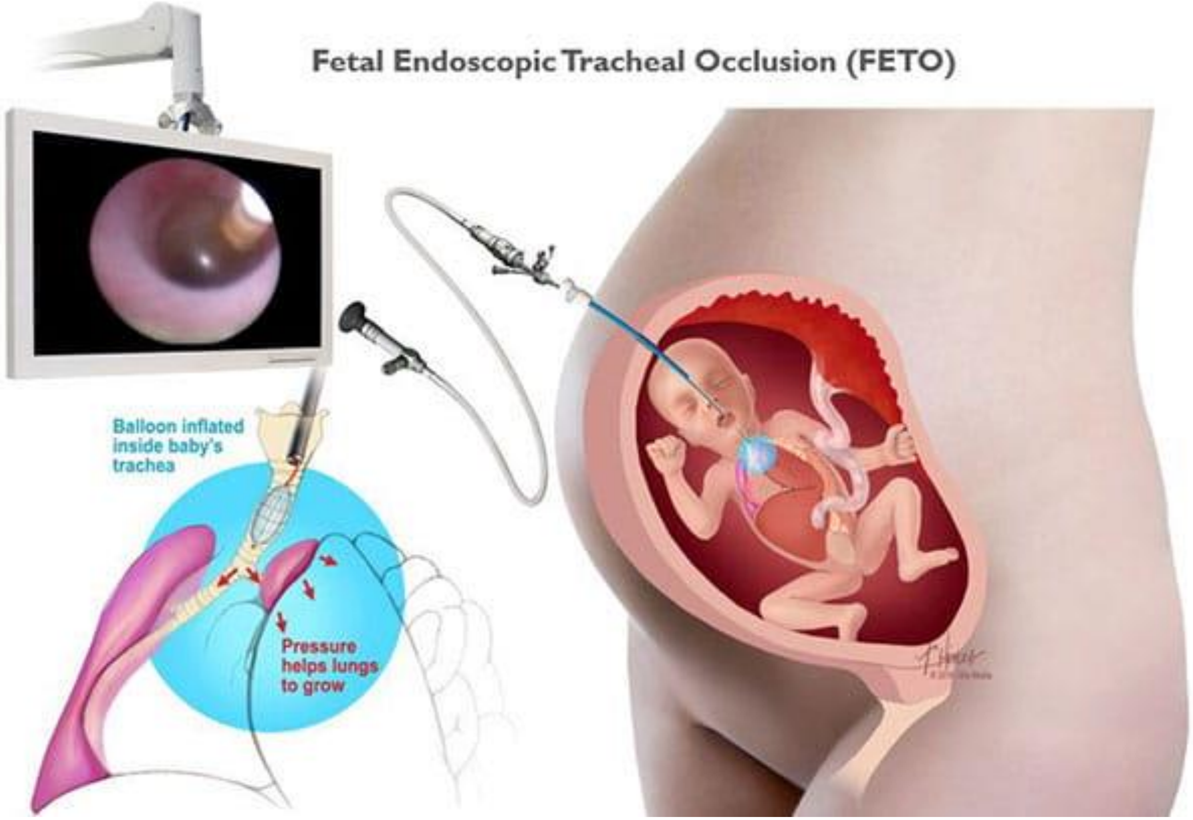
	TFLV o/e	Survival	
		Liver UP	Liver DOWN
Very severe	<15%	12%	40%
Severe	16–25%	40%	85%
Moderate	26–45%	65%	85%
Mild	>45%	75%	85%

Can we predict mortality?

- Yes, assessment of the vital risk is possible in the fetus with CDH;
- Consensual methods and indicators: O/E LHR, O/E MRI Lung volume;
- Standardized and reliable methods;
- Regular training at least in reference centres;

Prenatal assessment of vital risk:
impact for the management / research ?

Indication for Fetoscopic Endoluminal Tracheal Occlusion (FETO)



Picture from the *Cincinnati Children's Fetal Care Center*

Clinical trials

Stratification of the population according prenatal prognostic factors

J Deprest, NEJM 2021

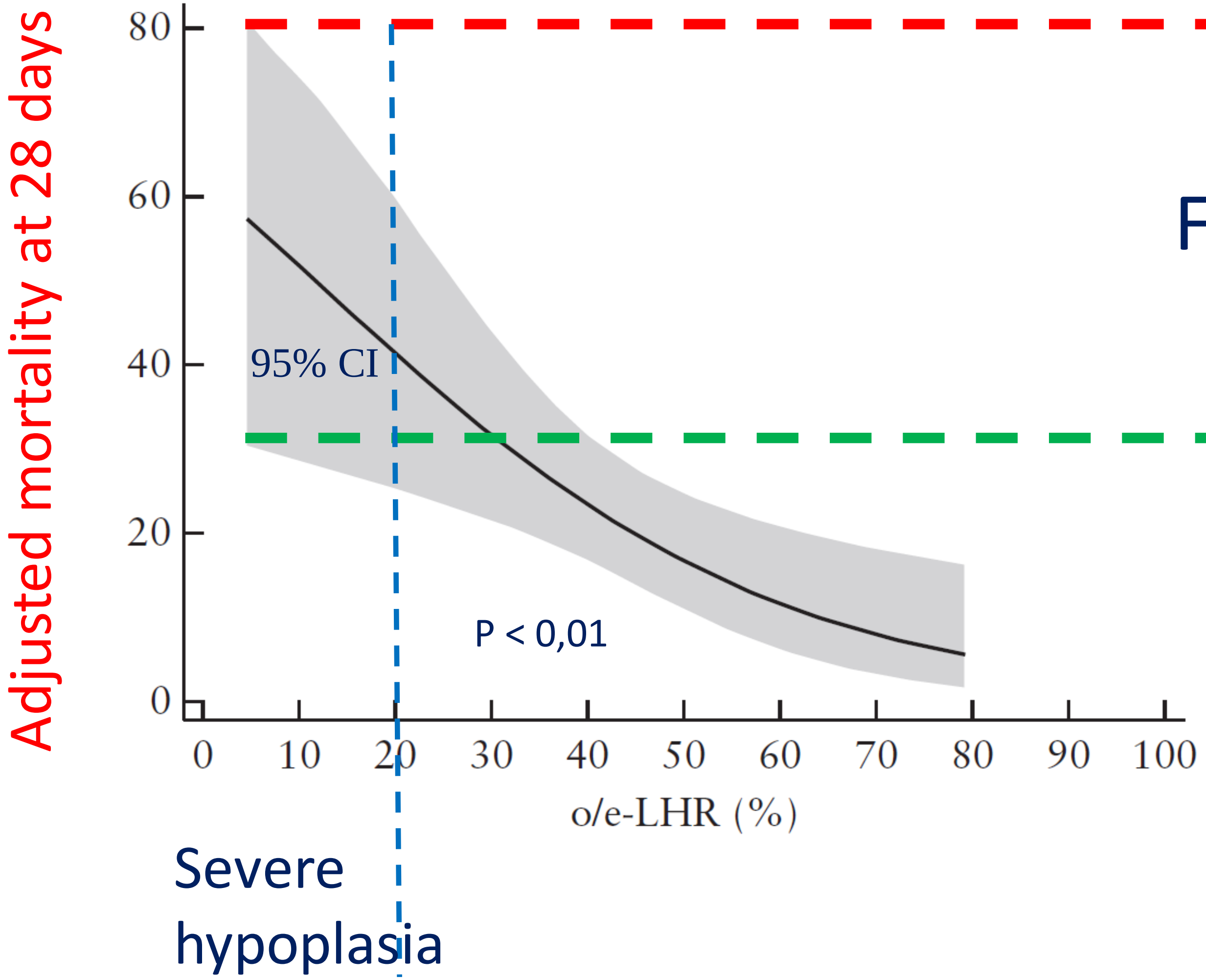
Prenatal assessment of vital risk:
Which information for the parents?

Mortality depends on lung size and liver position

Left CDH, liver UP	LHR o/e	Survival
Very severe	<15%	<5%
Severe	16–25%	20–30%
Moderate	26–45%	40–60%
Mild	>45%	95%

AG Cordier, Semin Perinatol 2020

Adjusted relationship between o/e-LHR and Mortality



From 30 to 80% !

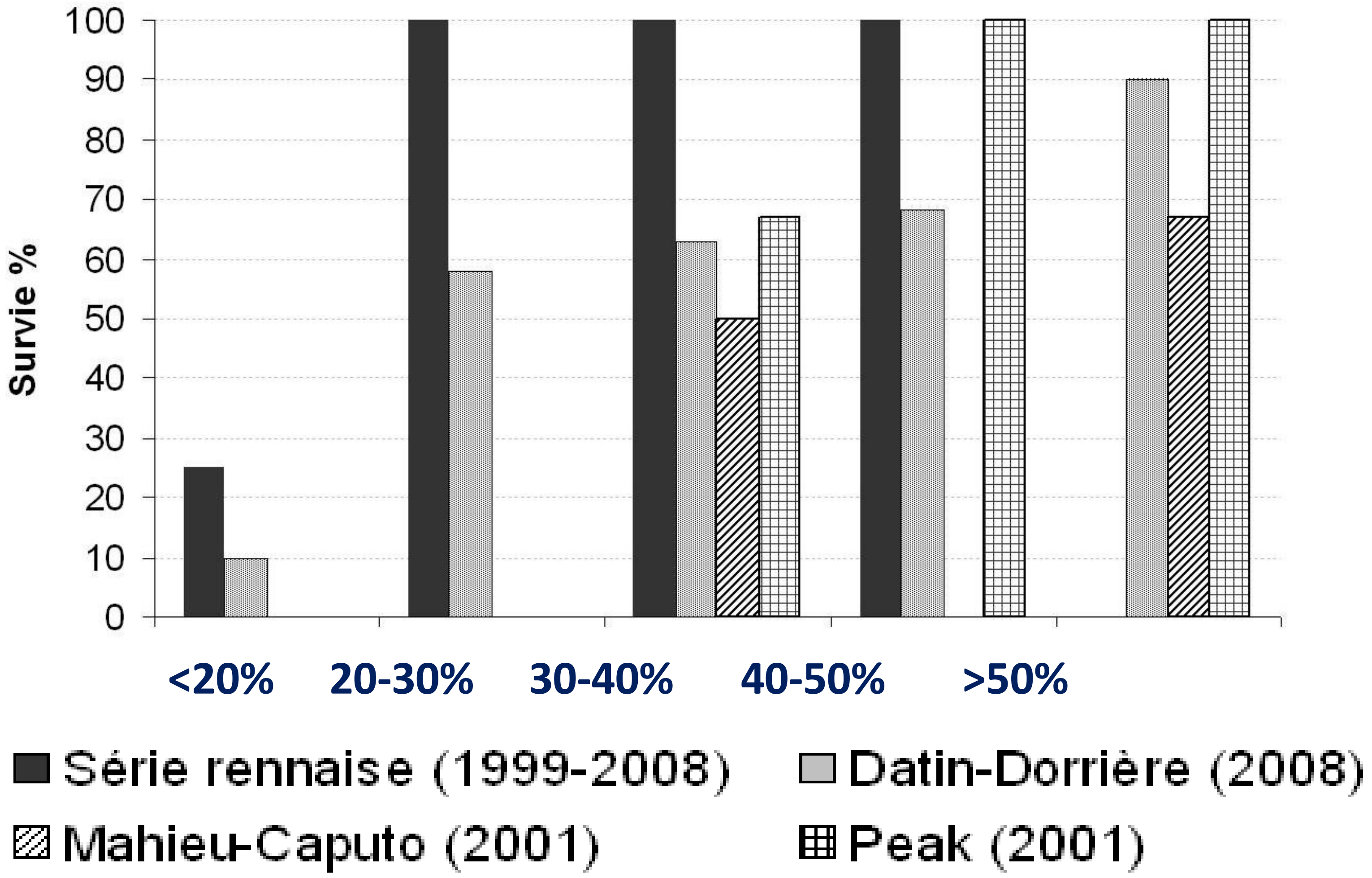
420 fetuses with CDH :

- **from 31 perinatal units**
- from 2008 to 2013

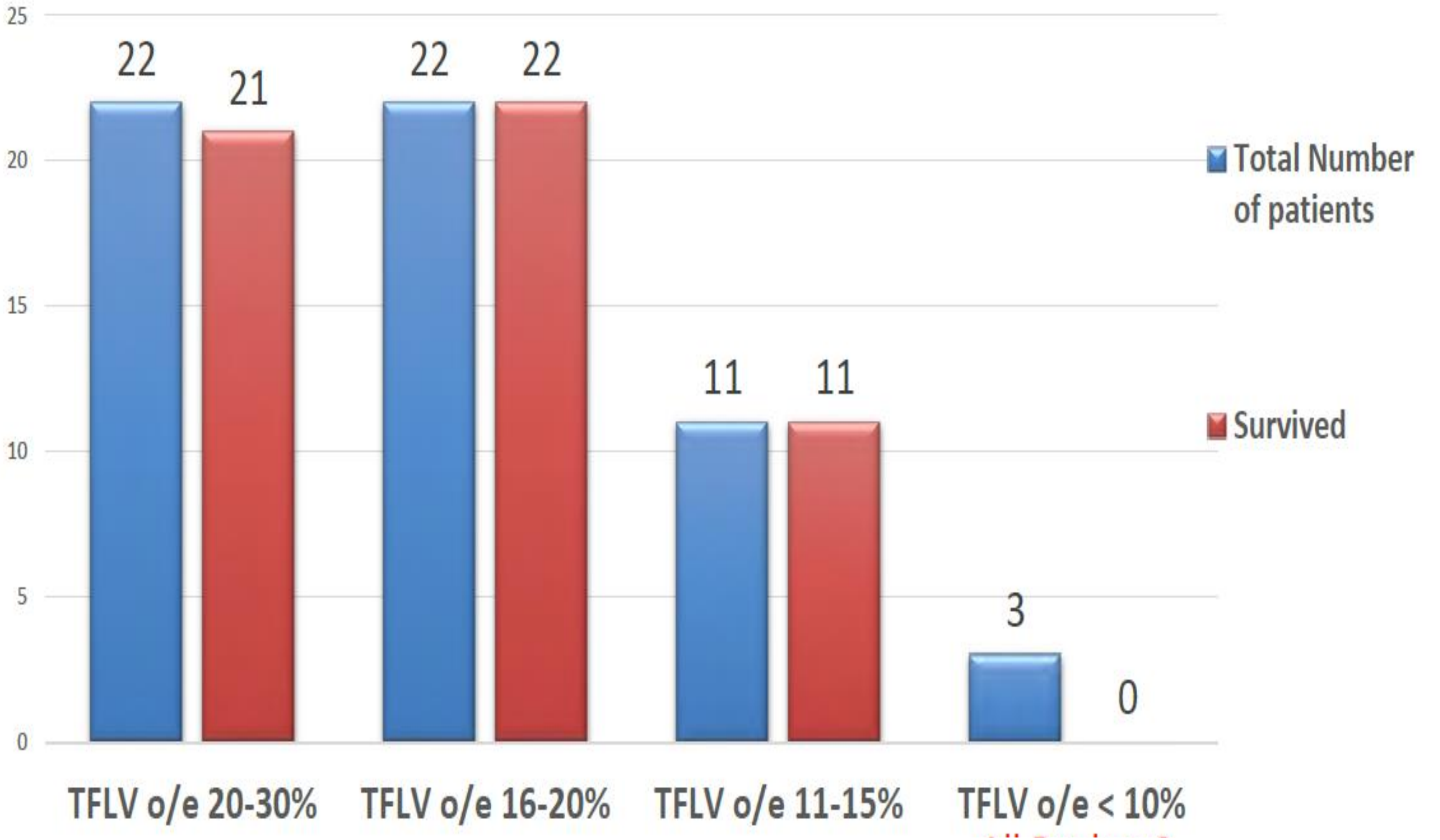
Senat MV et al. Ultrasound Obstet Gynecol 2018

High variability of mortality between centres in France despite fetal lung volume adjustment

Survival according fetal lung volume



Gaillot T, Arch Dis Child 2007

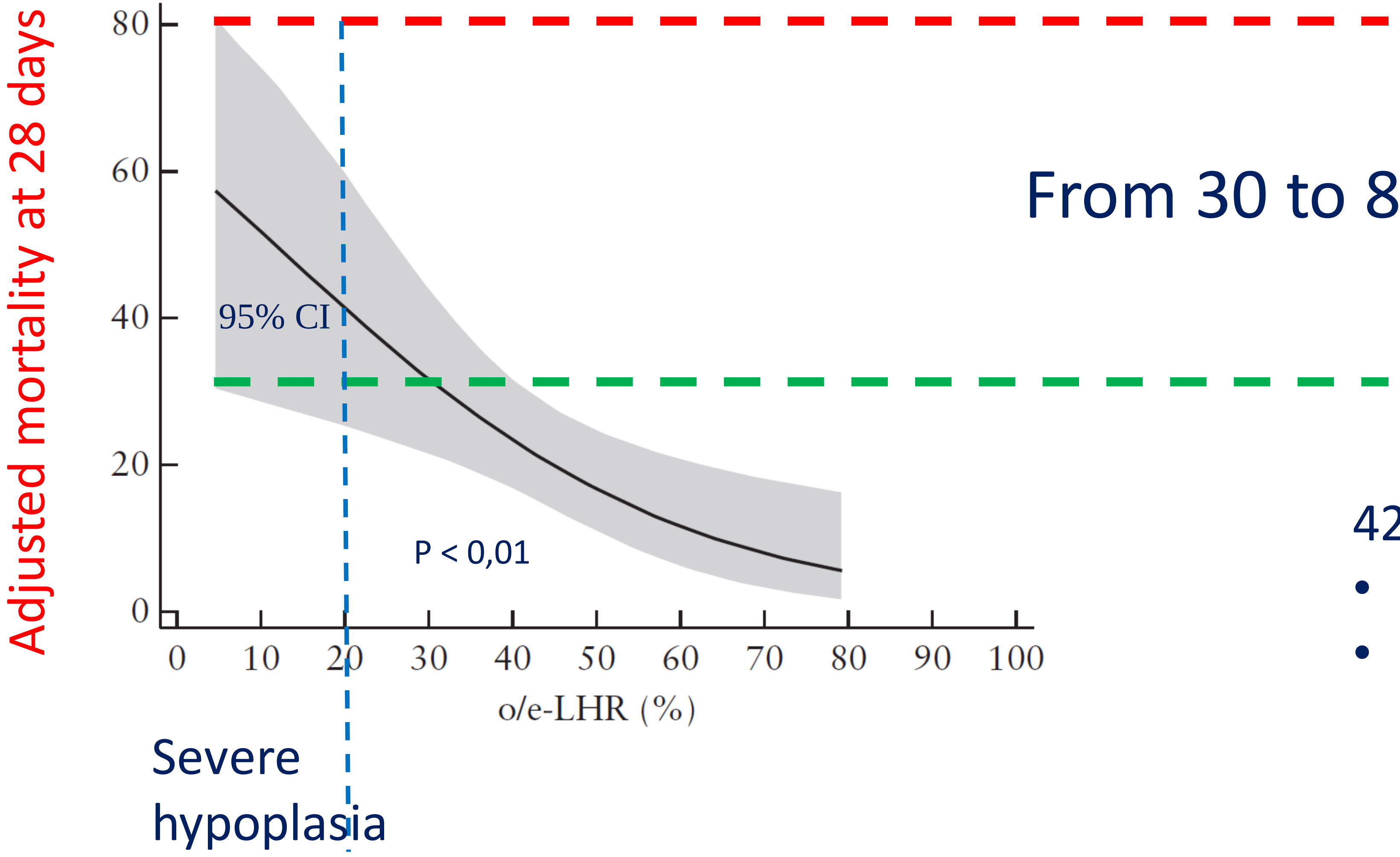


Survival adjusted
for the fetal lung volume

Survival 100%

Kays DW, John Hopkins Houston

Adjusted relationship between o/e-LHR and Mortality



Severe hypoplasia

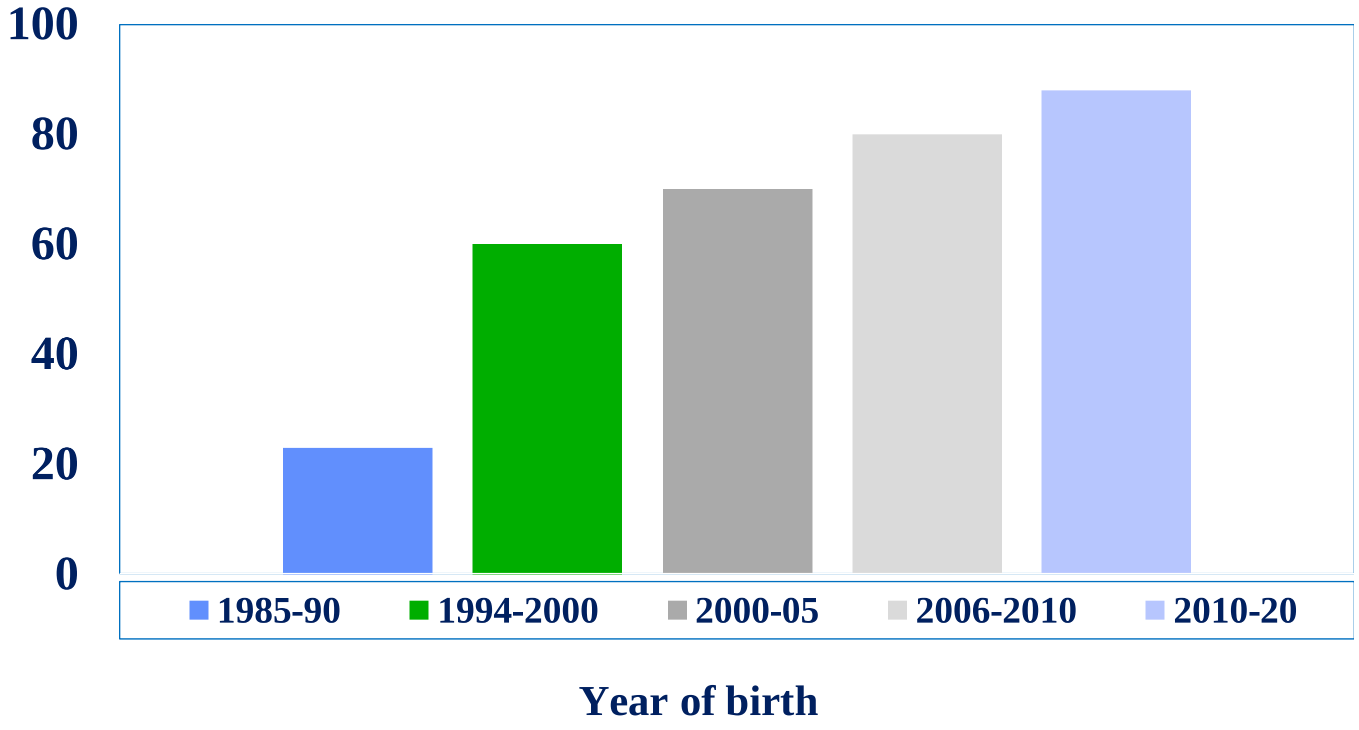
From 30 to 80% !

420 fetuses with CDH :

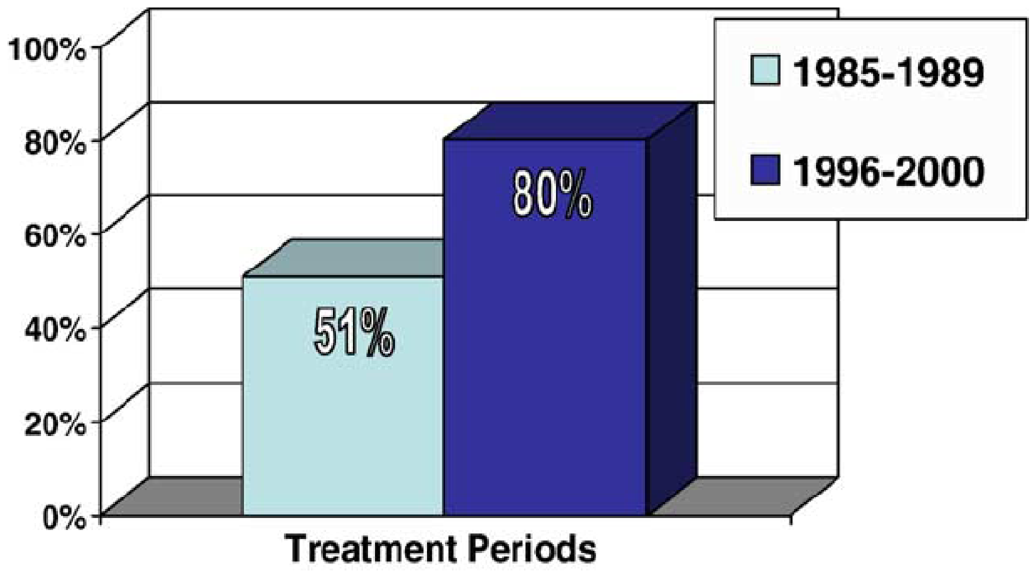
- from 31 perinatal units
- **from 2008 to 2013**

Senat MV et al. Ultrasound Obstet Gynecol 2018

Change in survival over time



Change in survival rate in the Nord – Pas de Calais area in France
N=420 CDH infants



Chiu P et al. J Ped Surg, 2006

Prenatal assessment of vital risk:
Effects of the self-fulfilling prophecy ?

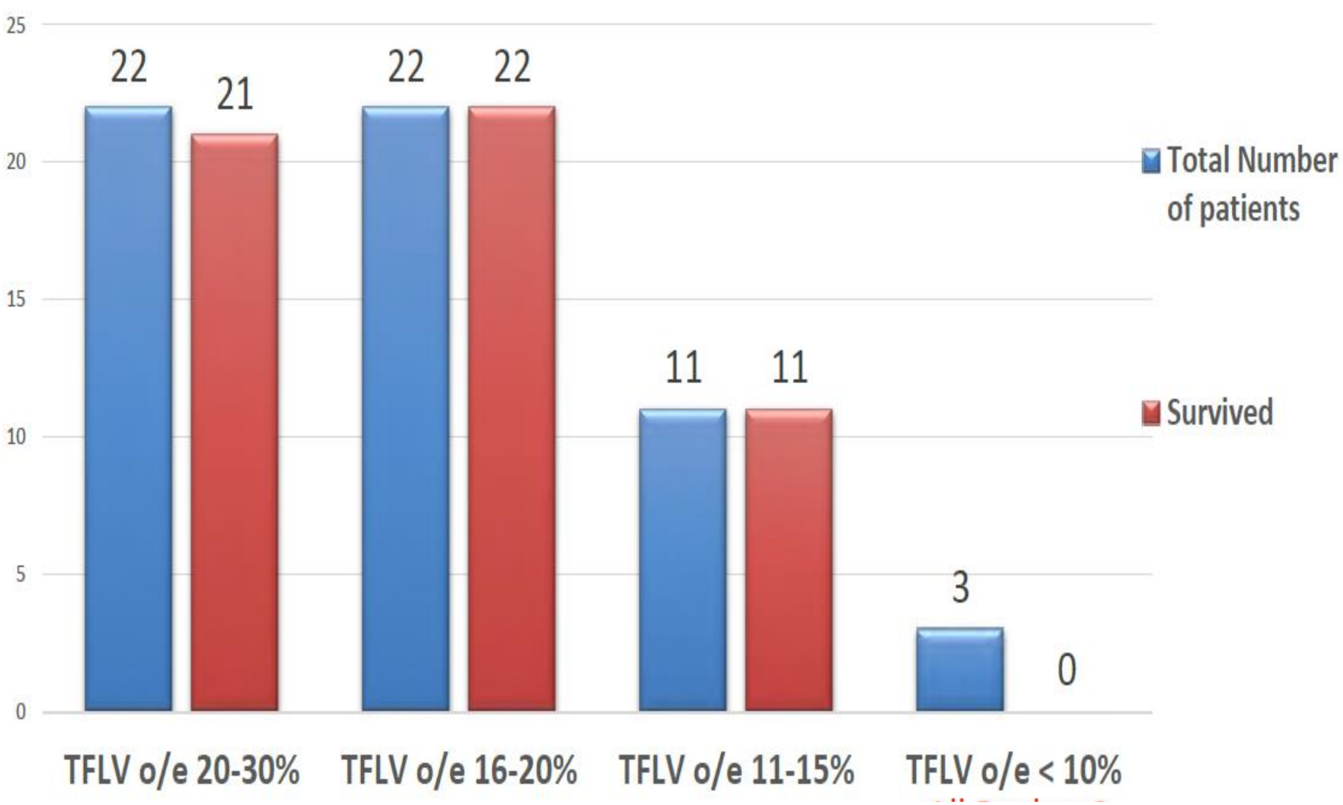
Left CDH, liver UP	LHR o/e	Survival
Very severe	<15%	<5%
Severe	16–25%	20–30%
Moderate	26–45%	40–60%
Mild	>45%	95%

< 30% survival

Possible biais through self-fulfilling prophecy shown in the following conditions:

- Limits of viability in the preterm baby *(EPIPAGE 1 vs 2, Stanak M, BMC Pediatr 2019);*
- Polymalformative syndrome *(Pfeifer U. J Matern Fetal Neonatal Med 2018);*
- Cerebral stroke in adult *(Montano R, Handb Clin Neurol 2021);*

AG Cordier, Semin Perinatol 2020



Survival adjusted for the fetal lung volume

Kays DW, John Hopkins Houston

What if we put it all together?

- Protect lungs
- Risk Stratify Repair timing
- Get Everyone Repaired
- Do Great ECMO
  - Good decision making
  - Minimize errors
- Believe they can Survive
- What If ?

- Believe they can survive
  - Minimize Errors
  - Learn from mistakes
  - Simplify care

Prenatal prognosis assessment:
What is at stake for the parents?

Mortality rate?

Left CDH, liver UP	LHR o/e	Survival
Very severe	<15%	<5%
Severe	16–25%	20–30%
Moderate	26–45%	40–60%
Mild	>45%	95%

Long-term outcome, the future of their baby

GRAEP, Arch Pediatr 2007

Nutritional outcome

	At 2 years N = 51	At 5 years N = 49
Oral aversion	18 (35%)	12 (25%)
Gastro-esophageal reflux	14 (30%)	7 (15%)
Growth retardation	9 (20%)	15 (30%)

S Jaillard et al. Ann Thorac Surg, 2003
S Jaillard et al. Eur J CardioThorac Surg, 2000

Respiratory outcome

	At 2 years N = 51	At 5 years N = 49
Tracheotomy	1	0
O2 supplementation	2 (5%)	0
Bronchiolitis	22 (50%)	0
Asthma	-	7 (15%)

S Jaillard et al. Ann Thorac Surg, 2003
S Jaillard et al. Eur J CardioThorac Surg, 2000

What is at stake ? Quality of life

- Score of the CDH patients similar to control;
- **No correlation between prenatal risk factors, severity of the disease, and the health-related quality of life;**

Derraugh G, Eur J Pediatr Surg 2020
Koivusalo A, J Pediatr Surgery, 2005
Jill L. Morsberger, J Pediatr Surg 2019

Key determinants of quality of life :

- Supportive environments: positive family coping, strong support network;
- Individual adaptability: motivation, hardiness;
- Resources and supports available to the family.

Quality of life, the future?

Our ability to respond to the parents needs:

- Empathy,
- Alliance,
- Relational commitment;

“As for the future,
it is not a matter of foreseeing it,
but of making it possible”

Antoine de Saint-Exupéry

CDH22

What matters to us: Personalising Support for people with CDH

Theoretical aspects of parental support

- ***Personalising Care for patients & families with CDH***

Kelly Saint Denny, Lille University Hospital

Practical aspects of parental support

- ***Family Integrated Care in CDH: lessons from Preterm Care***

Karel O’Brien, Mount Sinai Hospital, Toronto

- ***Implementing FICare for CDH***

Carolyn McConnell, Royal Hospital for Children, Glasgow