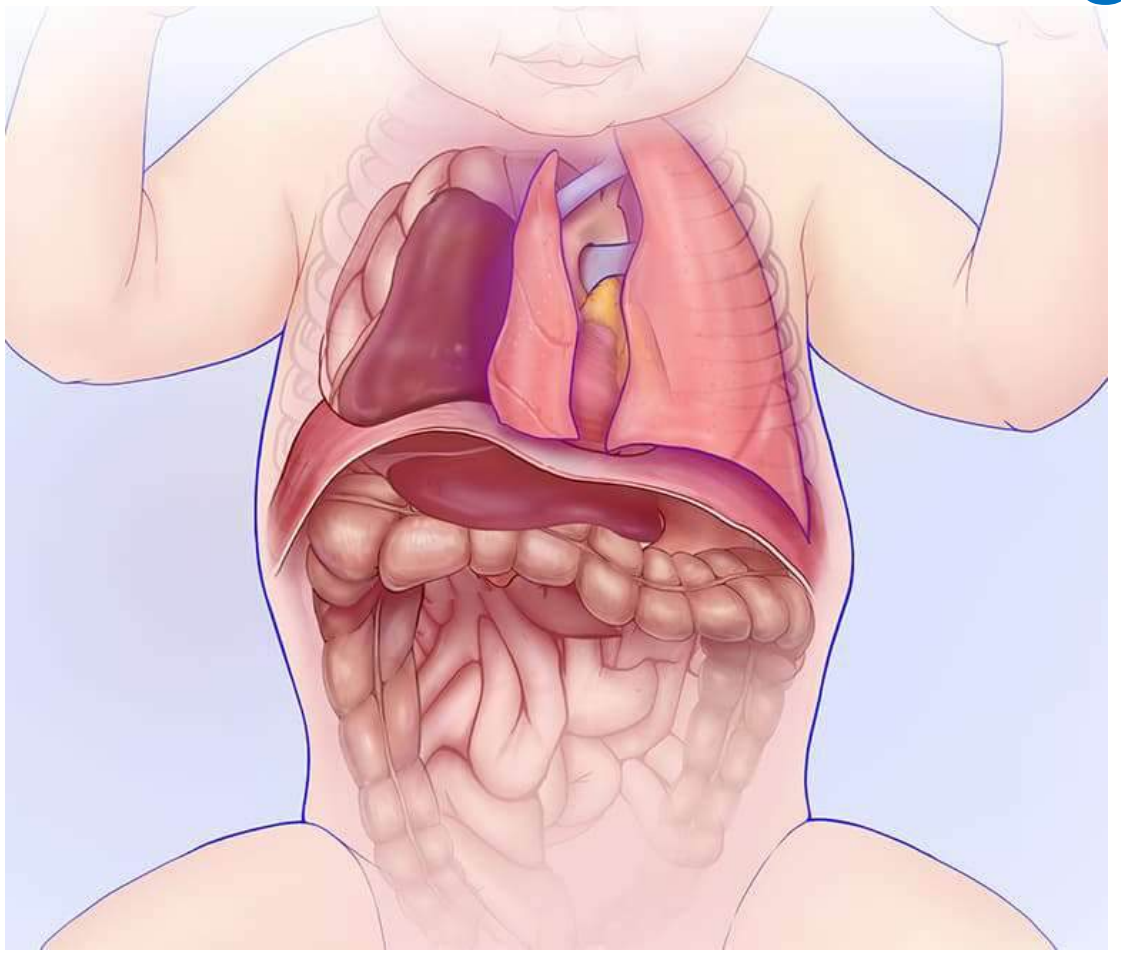
The Congenital Diaphragmatic Hernia Story: Three Decades of Care in the Center for Fetal Diagnosis and Treatment

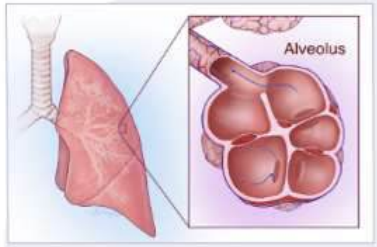


Holly L. Hedrick, MD

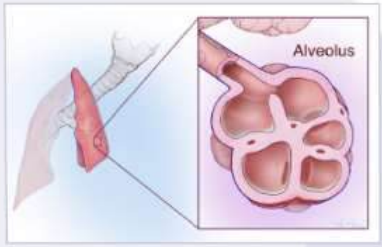
David W. Wood, MD Distinguished Chair in Pediatric Surgical Science
Surgical Director, Extracorporeal Membrane Oxygenation (ECMO) Center
Co-Director, Neonatal Surgical Team
Director, Pulmonary Hypoplasia Program

AIRWAY

Normal



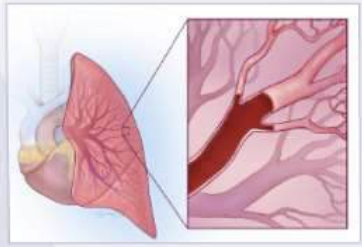
CDH



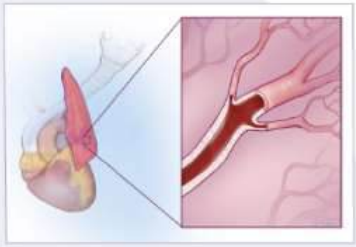
Lung hypoplasia
Acinar hypoplasia
Thickened mesenchyme
Decreased airway branching
Decreased alveolarization

VASCULAR

Normal



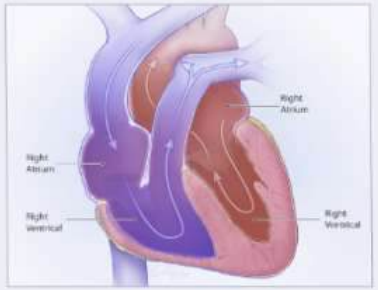
CDH



Vascular bed hypoplasia
Medial hyper muscularization
Adventitial thickening
Altered vasoreactivity
Decreased vascular branching

CARDIAC

Normal



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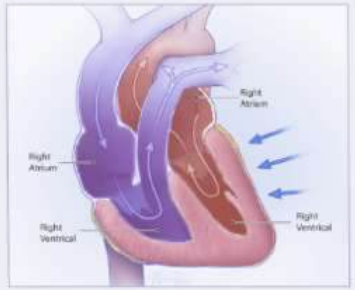


Left ventricular hypoplasia
Right ventricular hypertrophy
Impaired coronary perfusion

2020

CDH at CHOP: An Overview

CURRENT CLINICAL PROGRAM

CENTER FOR FETAL DIAGNOSIS & TREATMENT
1995

- Ultrasound/MRI
- Echocardiography
- Pediatric Surgical Consultation
- Maternal-Fetal Medicine/Genetics Consultation
- Psychosocial Support
- Fetoscopic Endoluminal Tracheal Occlusion (FETO)

GARBOSE SPECIAL DELIVERY UNIT (SDU)
2008

- Planned Delivery
- Interdisciplinary Resuscitation
- Avoid Neonatal Transport
- Keep Family Together
- Psychosocial Support
- Delivery Room of the Future 2023-25

NEONATAL SURGERY TEAM
2004

- Neonatal Co-management
- ECMO
- Surgery in N/IICU
- Pulmonology
- Cardiology
- Nutrition
- Developmental Care
- Psychosocial Support
- CDH Pathway *LIVE* 2024

PULMONARY HYPOPLASIA PROGRAM
2004

- Pediatric Surgery
- Nutrition
- Pulmonology
- Cardiology
- Neonatal Follow-up
- Neurodevelopmental Psychology
- Audiology
- Psychosocial Support

CDH FRONTIER PROGRAM
2020-22

- Translational Research
- Expanded Collaboration
- CDH Management biweekly
- Quality Improvement
- Clinical Outcomes Research Lab
- Clinical Outcomes Data Archive (CODA)

Opportunities

- Travel/Lodging
- Accurate Prenatal Prognosis
- Prenatal intervention
- Team Counseling

- Standardized approach
- Resuscitation
- Ventilation Strategies

- Optimization of ECMO
- Pulmonary Hypertension
- Building Babies Brains
- Feeding

- Travel/Lodging
- Patient Follow-up
- Quality of Life
- Readmissions

- Bench to bedside
- Infant Transitional Unit (4E)
- Remote Patient Monitoring Transitions
- National Competition




EACH PATIENT, EVERY OUTCOME MATTERS



VOLUMES OF DATA ARE REQUIRED TO PRODUCE MEANINGFUL RISK-ADJUSTED OUTCOMES

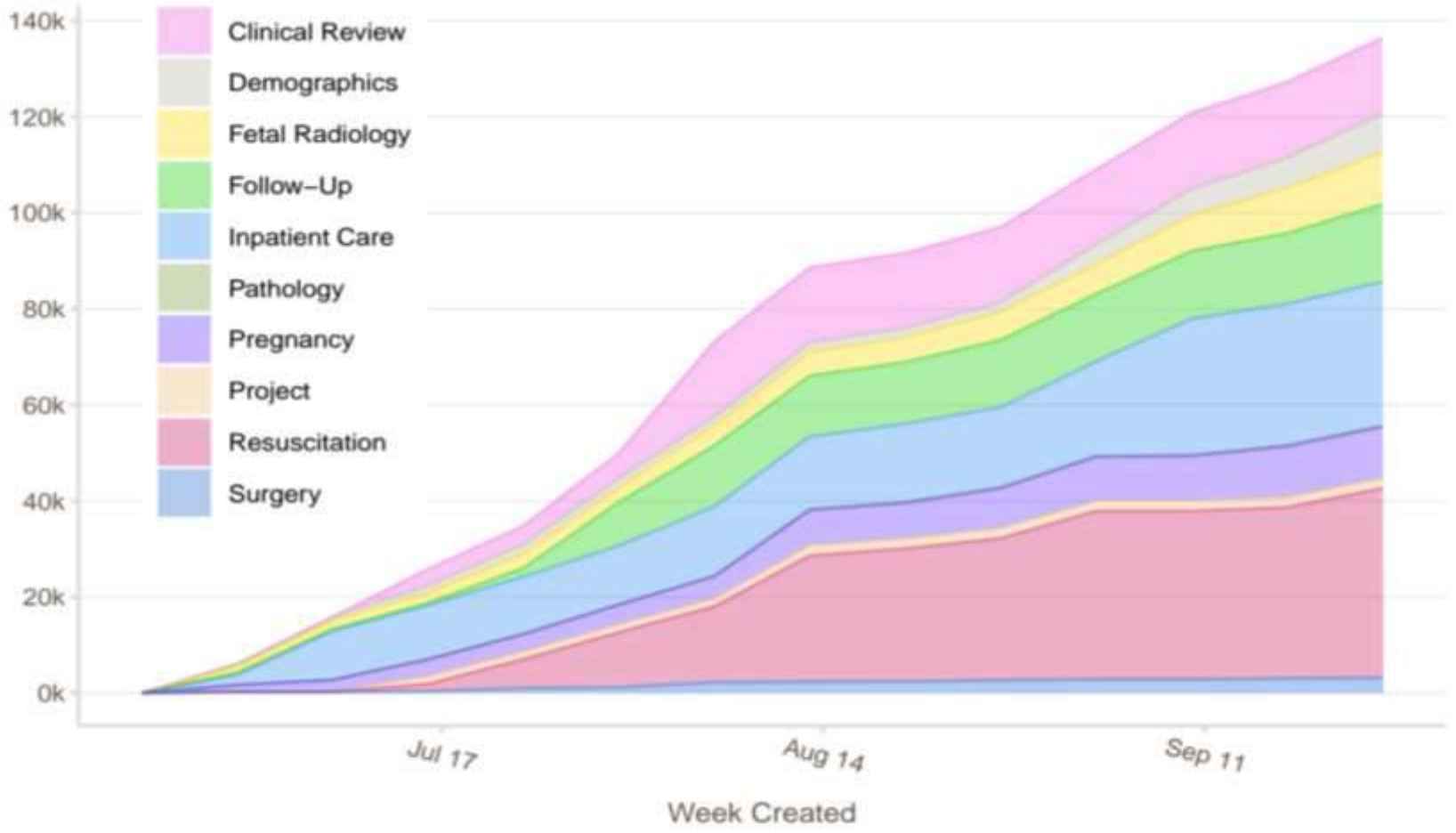
CDH patients in CODA

(Clinical Outcomes Data Archive)

809 pregnancy/mother

918 children

Cumulative Validated Data Points FY 24



Prenatal Predictors of Outcome in CDH

1. Syndromic? Genetic difference?
2. Cardiac disease
3. Liver position and lung size

CDH Clinical Classification

Isolated (60-80%)
CDH is the only apparent major malformation

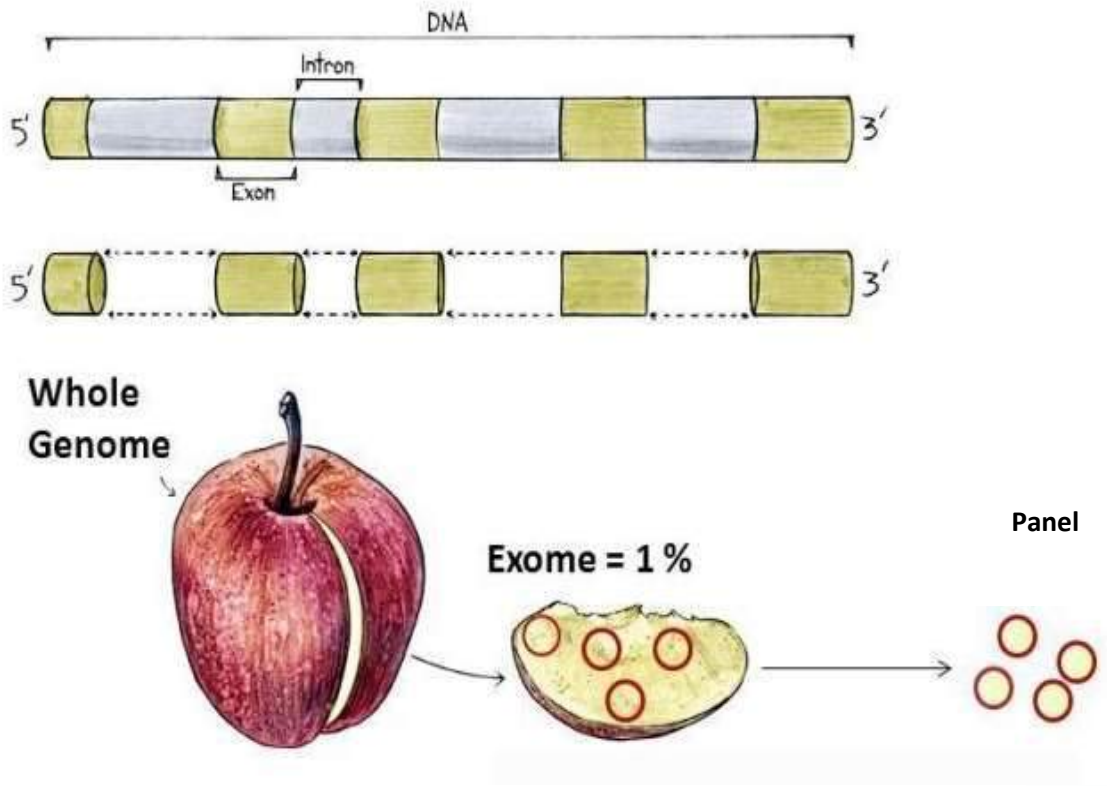
VS.

Syndromic (20-40%)
CDH occurs with additional abnormalities (e.g. as part of a recognized syndrome)

Most Common Syndromic Diagnoses:
trisomy 18, tetrasomy 12p/Pallister Killian, Emmanuel, Simpson-Golabi-Behmel, Cornelia de Lange, CHARGE, Coffin Siris, Saethre-Chotzen, Beckwith Wiedemann

Genetic Testing in CDH

- Clinical standard of care used to ONLY include a microarray
- +/- gene panels or exome/genome ONLY in the presence of concern for syndromic CDH
- New standard of care: genome sequencing



Cardiac disease increases mortality in CDH

Prenatal Evaluation:

- **Fetal Echocardiogram in all cases**
- **Most frequent associated anomaly**

- CHOP 1996-2000, 31/143 patients (18%)
- Risk of death 3X higher, CDH + CHD 20%, none survived with LHR <1.2
- TOP or NND 17%, CDH alone survival 58%

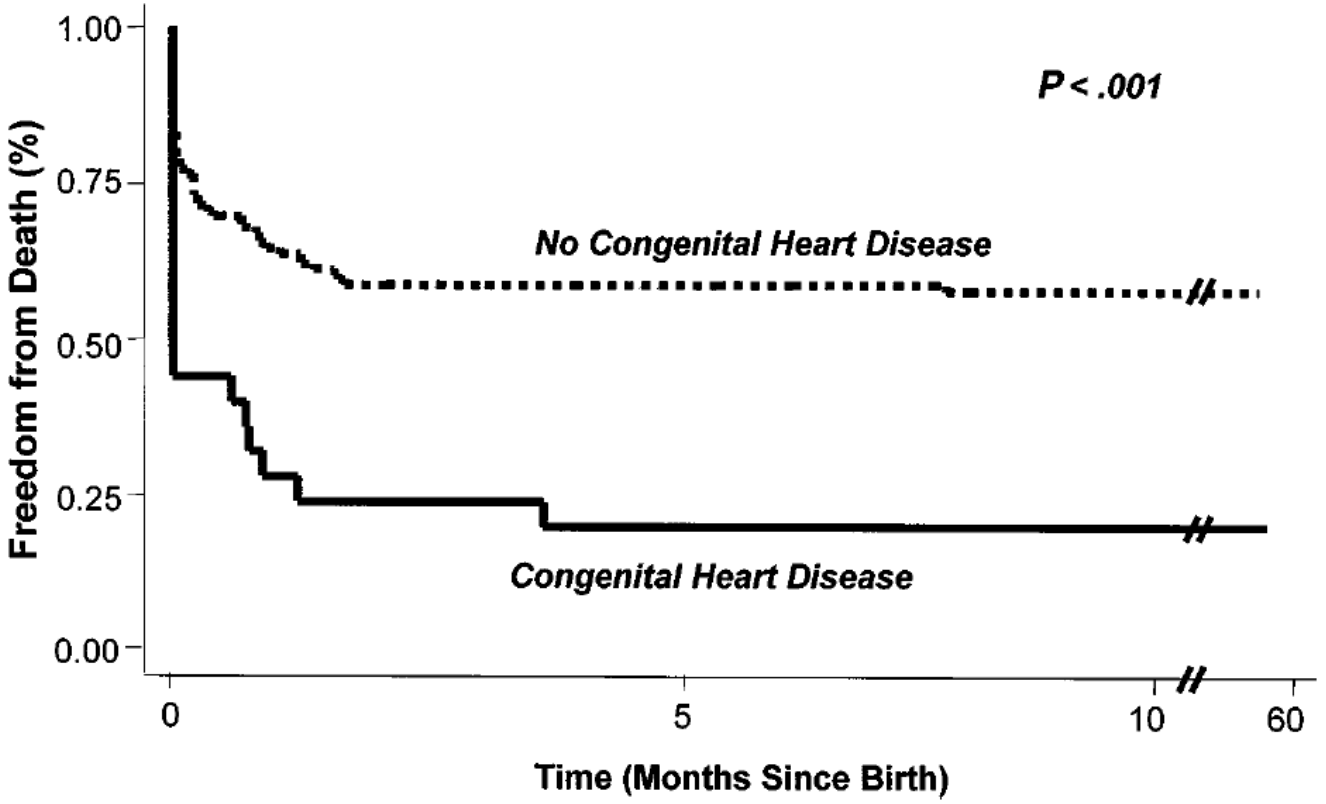
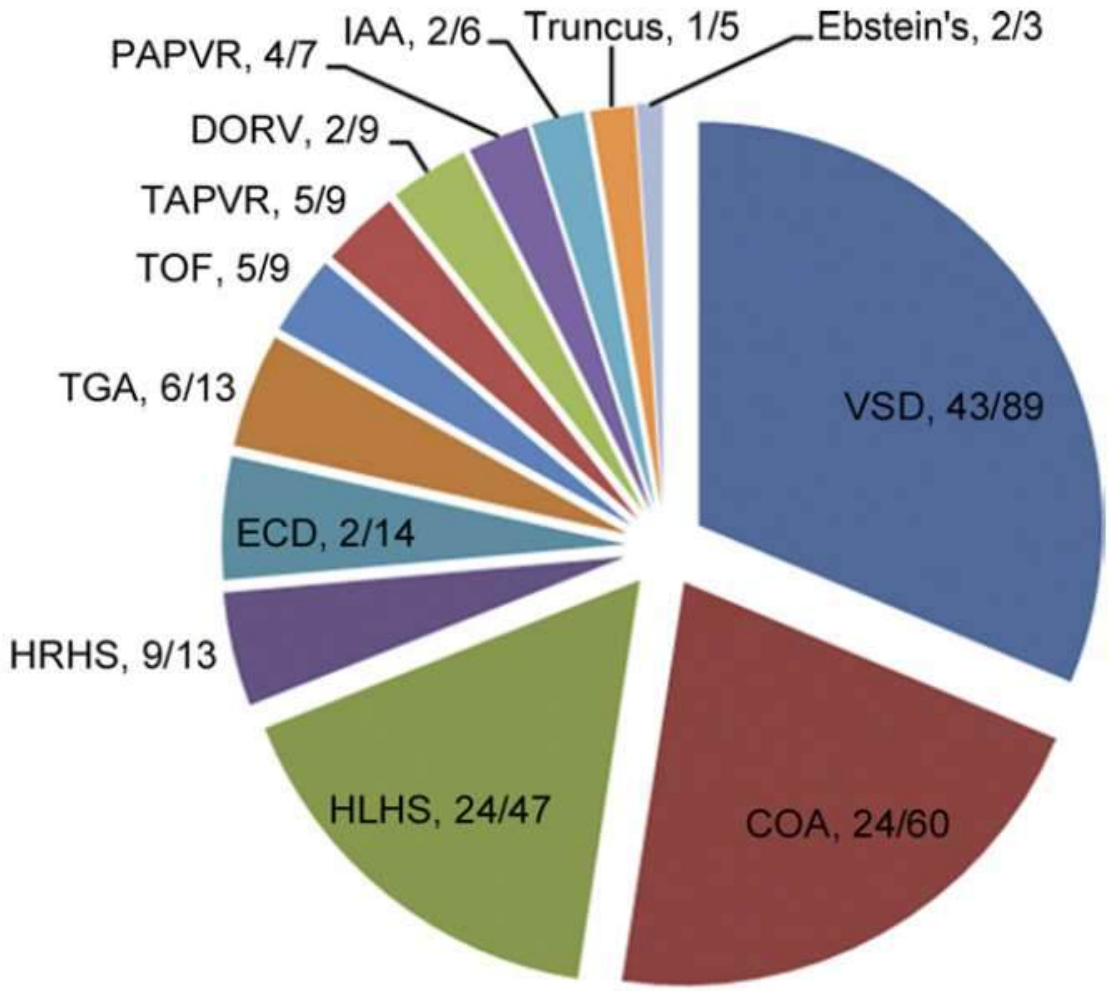


Figure. Survival from birth to time of last follow-up (in months) for infants who survived to term, stratified on presence of congenital HD.

J Pediatr 2002;141:25-30

With ECMO CDH + CHD Survival Possible

- ELSO Registry 1998-2010
- 9% of CDH also with CHD
- Overall survival 47%



Ann Thorac Surg 2013;95:1373-6

CDH + CHD Systematic Review: It's worth a shot

Critical CHD = single ventricle, ductal dependent pulmonary or systemic circulation, total mixing lesions

CDH repair 72%
ECMO 28%

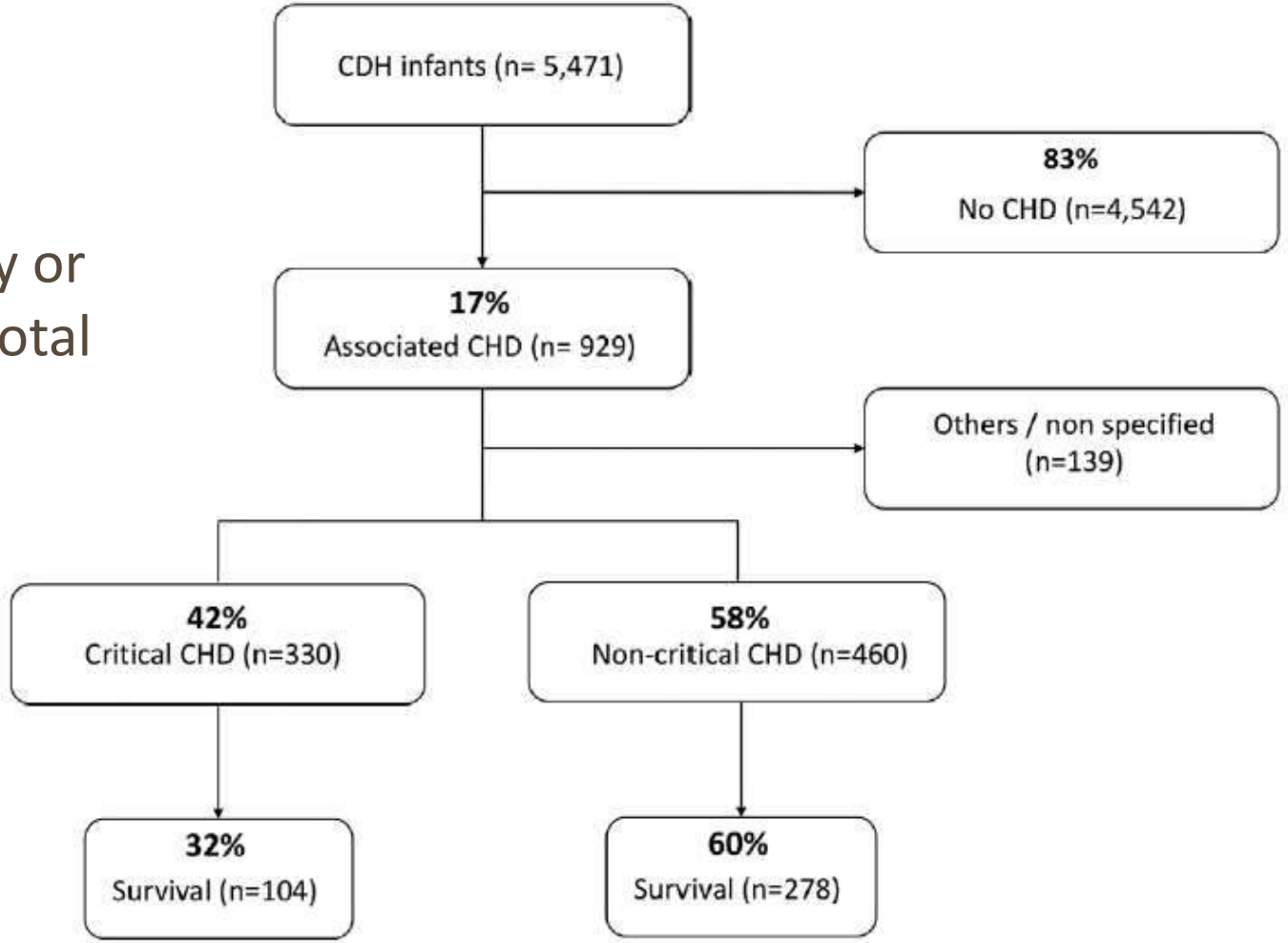
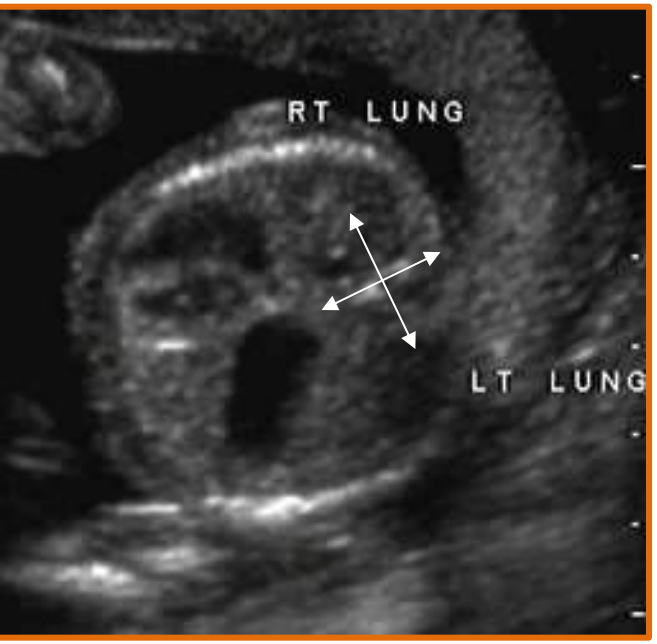
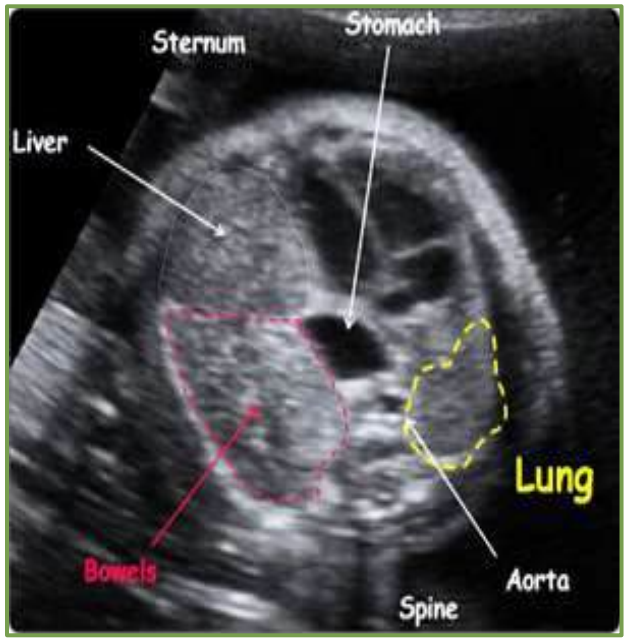


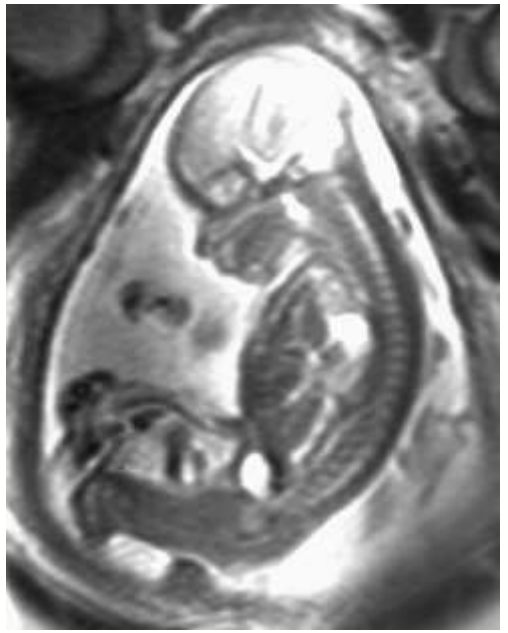
Fig. 3. Survival of infants with CDH associated with CHD.

JPS 54(2019) 909-919

Liver Position and Lung Size







J Pediatr Surg 1996;31:148
Ultrasound Obstet Gynecol.2007;30:72e6
Ultrasound Obstet Gynecol 2005;26(7):738
Am J Roentgenol 2018;211(2):432

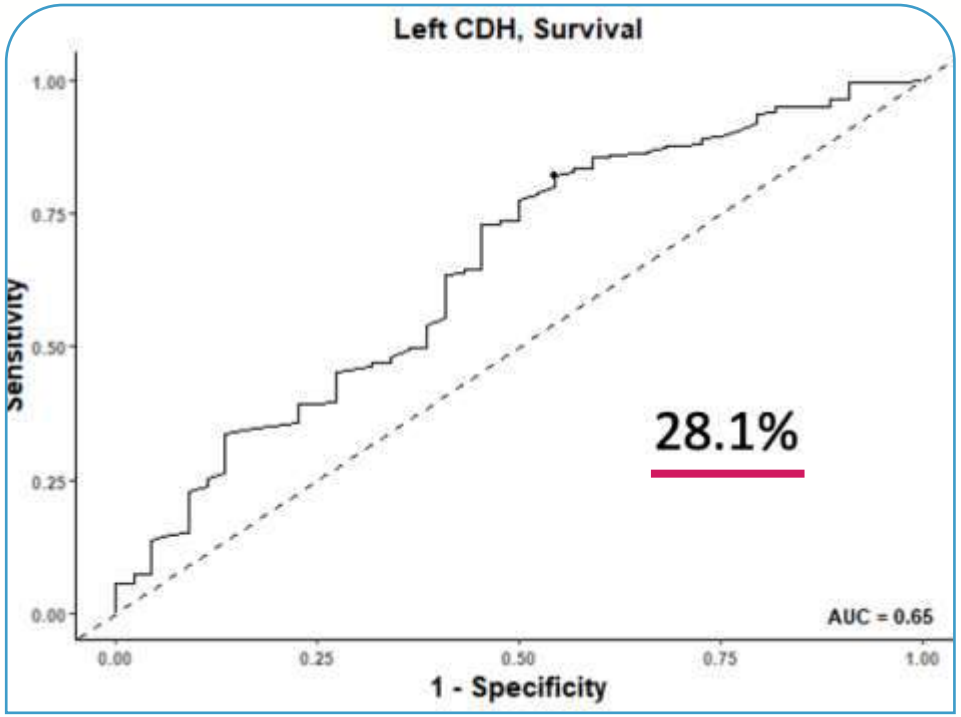
- Liver Position
- Postnatal survival directly related to LHR
- Large difference in reported results
  - Measured at different gestational ages
  - Method of measuring LHR
  - Development of observed /expected(O/E) LHR

MRI
- Liver position
- Stomach position
- Observed/ expected Total Lung Volumes
- Rypens, Meyers

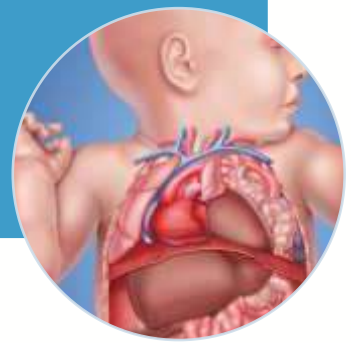
*** Severe CDH defined as US LHR O/E < 25%**

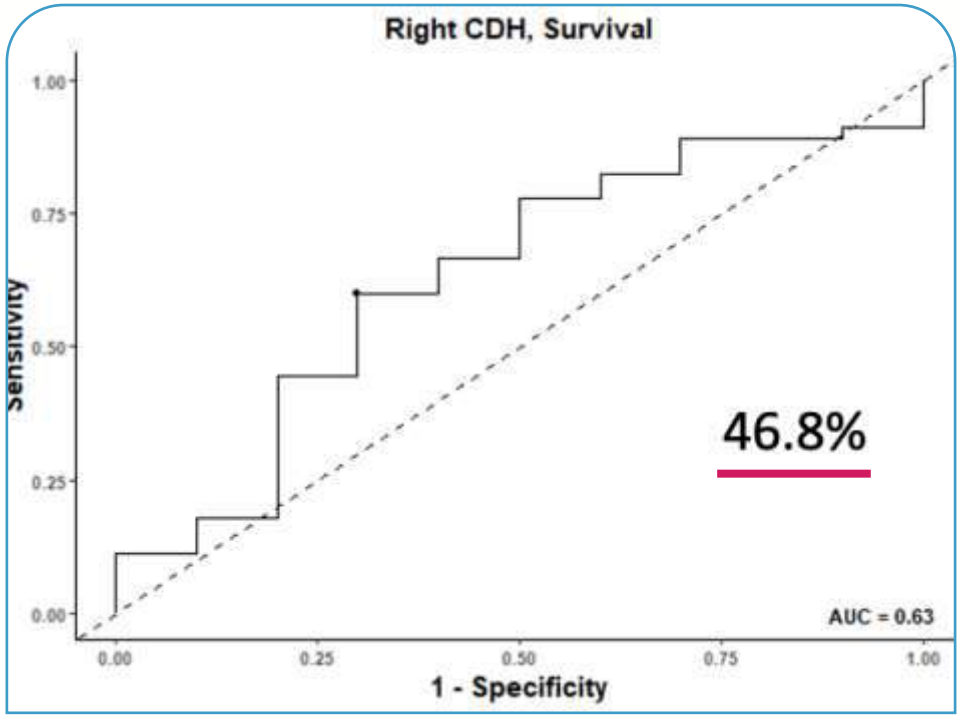
Predicting Survival Using Ultrasound O/E LHR

Gebb et al., Presented 4/19/24, CDH International, Lille, France

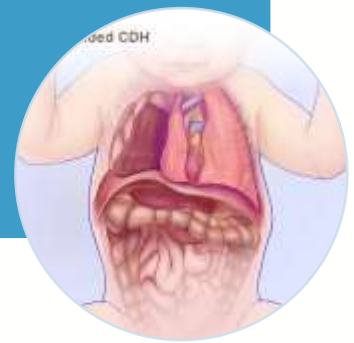


L CDH





R CDH

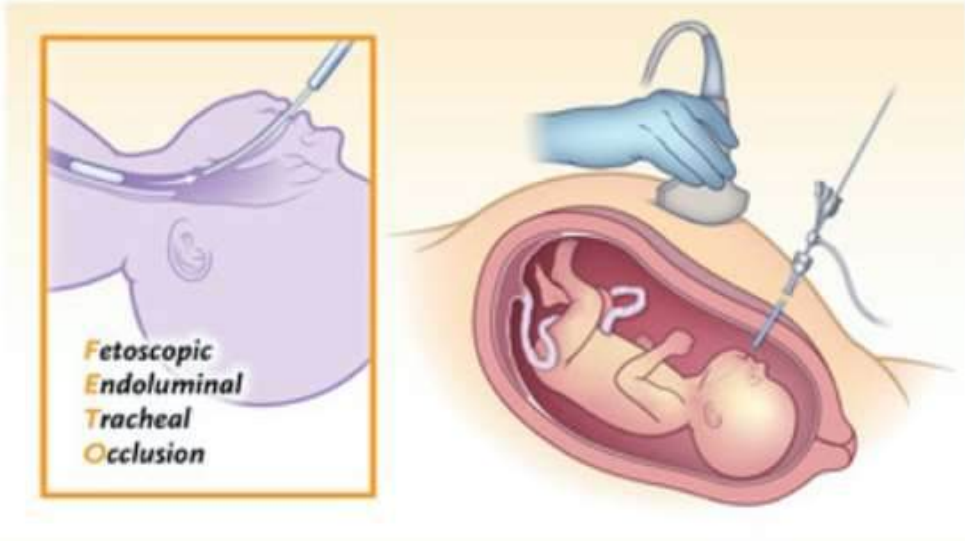


Prenatal Intervention To Make Outcomes Better?

RESEARCH SUMMARY

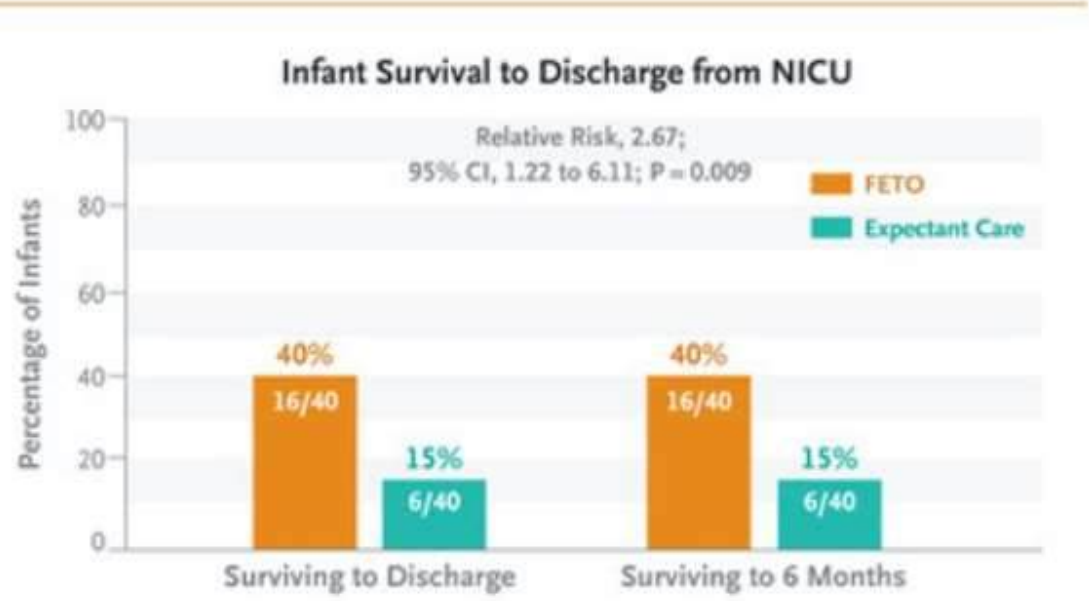
Randomized Trial of Fetal Surgery for Severe Left Diaphragmatic Hernia

Deprest JA et al. DOI: 10.1056/NEJMoa2027030



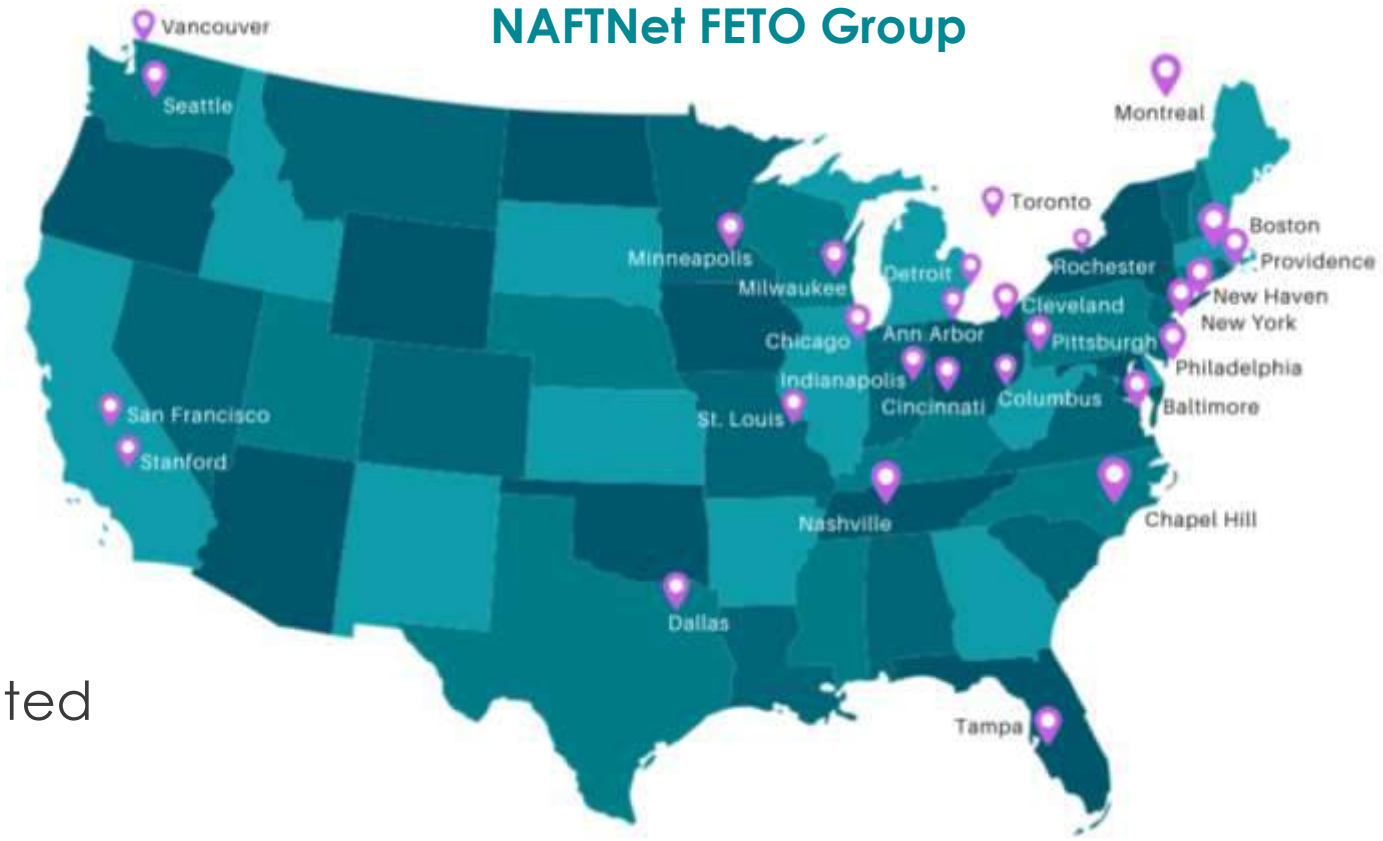
CONCLUSIONS

The use of FETO in fetuses with isolated severe congenital diaphragmatic hernia on the left side resulted in increased survival to hospital discharge but an increased risk of preterm, prelabor rupture of membranes and preterm birth.



North American Fetal Therapy Network Feasibility Study

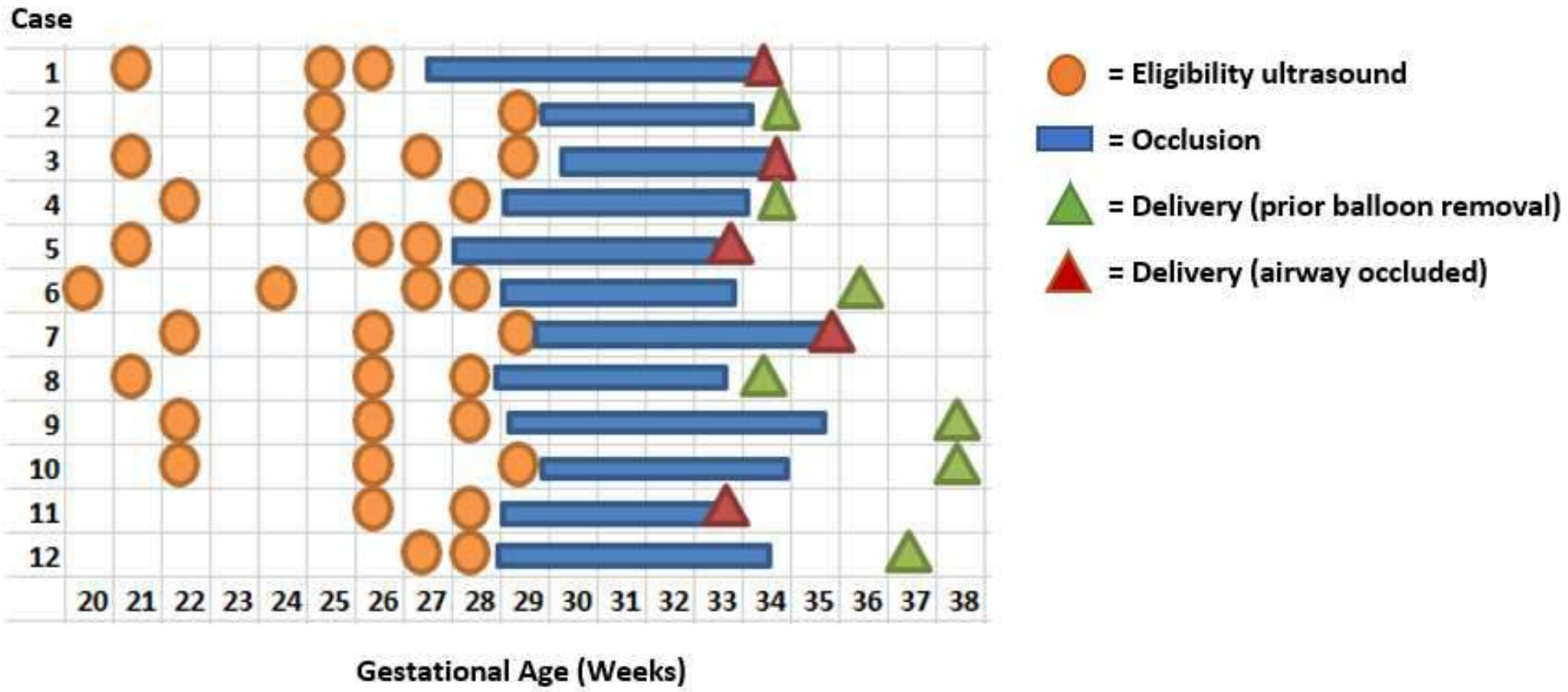
- Pitch for collaboration with EuroFetus 2007
- TOTAL started 2009
- Access to BALT balloon:
  - FDA face to face 2012
  - IDE approval December 2015
- Training
- FETO sites expanded
- FETO criteria modified
- Long term follow up registry mandated



Patient Selection

- Patients seen multiple times to confirm eligibility and requirements
  - Fetal Ultrasound
  - Fetal MRI
  - Interdisciplinary counseling
- Psychosocial
  - Social work
  - Psychology evaluation
- Commitment to relocation and follow up

Prenatal Timeline



FETO Procedure

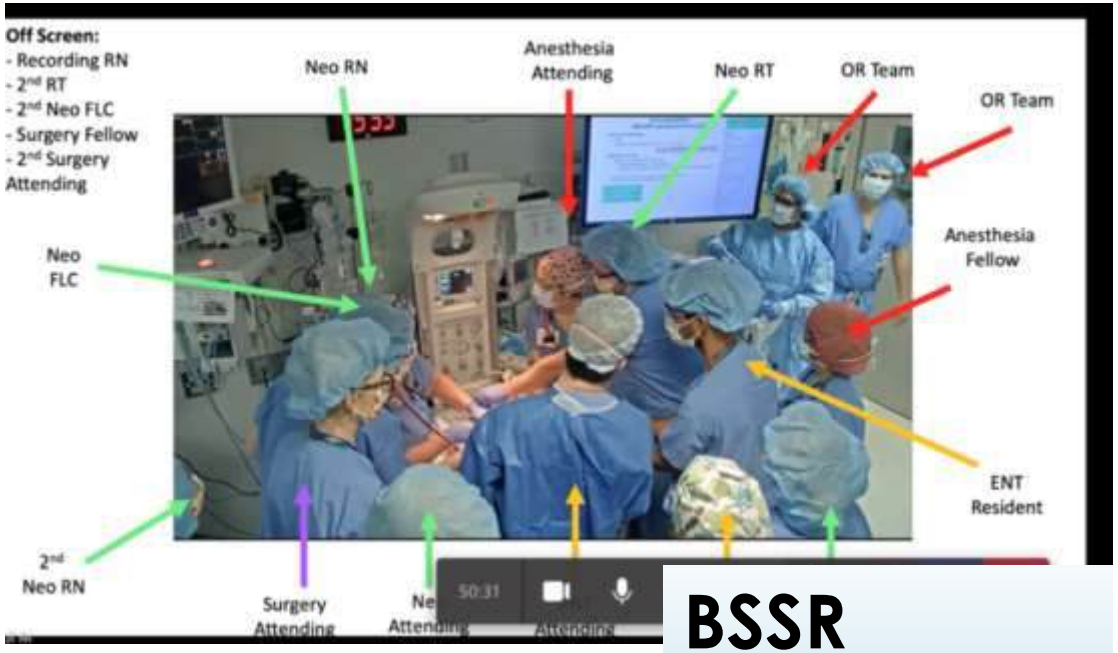
	Overall (N=12)
GA at insertion (weeks)	
Median [Q1, Q3]	29.6 [29.0, 30.1]
Prenatal position at balloon insertion	
Breech	7 (58.3%)
Vertex	4 (33.3%)
Transverse	1 (8.3%)
Trocar location	
Lower uterine segment	6 (50.0%)
Mid	3 (25.0%)
Upper uterine quadrant	3 (25.0%)
Total time trocar remained in utero during insertion (min)	
Median [Q1, Q3]	22.0 [18.8, 47.3]
GA at fetal balloon removal (weeks)	
Median [Q1, Q3]	34.4 [34.1, 34.9]
Fetal position at successful balloon removal	
Breech	1 (8.3%)
Vertex	11 (91.7%)
Total time trocar remained in utero during successful balloon removal (minutes)	
Median [Q1, Q3]	5.50 [0, 13.0]
Balloon removal route: Successful attempt	
Bronchoscopy	5 (41.7%)
Fetoscopic	6 (50.0%)
Ultrasound guided needle puncture	1 (8.3%)

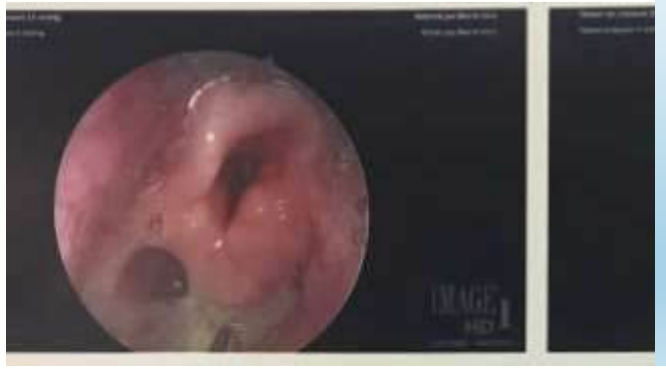
Maternal Outcomes

	FETO (N=12)	Control (N=35)	Overall (N=47)
Method of delivery			
Cesarean Section	10 (83.3%)	13 (37.1%)	23 (48.9%)
EXIT	2 (16.7%)	0 (0%)	2 (4.3%)
Vaginal	0 (0%)	22 (62.9%)	22 (46.8%)
Chorioamniotic membrane separation			
	6 (50.0%)	1 (2.9%)	7 (14.9%)
Premature rupture of membranes			
	9 (75.0%)	4 (11.4%)	13 (27.7%)
Time between ROM and delivery (hours)			
Median [Q1, Q3]	12.5 [6.75, 222]	4.00 [1.00, 7.50]	5.00 [2.50, 10.0]
Total duration of maternal hospitalization this pregnancy (days)			
Median [Q1, Q3]	13.5 [7.00, 25.3]	3.00 [3.00, 4.00]	4.00 [3.00, 6.50]

Neonatal Airway And FETO

- Team 24/7/365
- Simulations, drills, video review
- Balloon removal
- Tenacious secretions
- Surfactant
- Lung recruitment
- Volumetric Diffusive Respirator (VDR)
- Vocal cord function normal in all
- Tracheomalacia common, improves
- Tracheomalacia common, improves



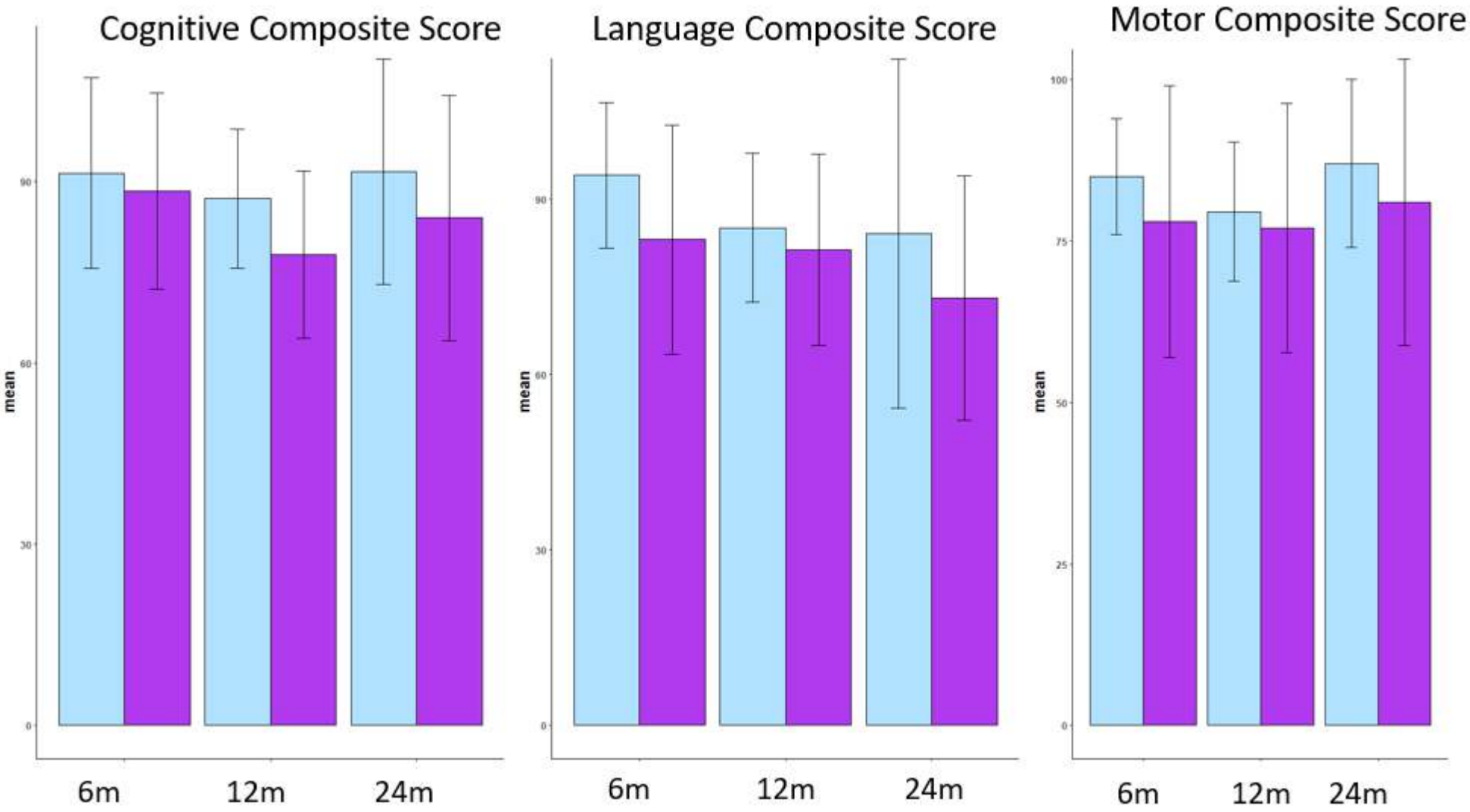


BSSR
Balloon
Secretions
Surfactant
Recruit

Neonatal Outcomes

	FETO (N=12)	Control (N=35)	Overall (N=47)
Gestational Age at Birth (wks)			
Median [Q1, Q3]	35.0 [34.3, 36.8]	38.9 [38.3, 39.5]	38.5 [35.4, 39.3]
Preterm birth			
Preterm	9 (75.0%)	6 (17.1%)	15 (31.9%)
ECMO			
	3 (25.0%)	21 (60.0%)	24 (51.1%)
CDH Repair			
	12 (100%)	31 (88.6%)	43 (91.5%)
Survival to discharge			
	11 (91.7%)	25 (71.4%)	36 (76.6%)
Pulmonary hypertension medications @ discharge			
Yes	0 (0%)	7 (28.0%)	7 (19.4%)

Early Childhood Neurodevelopmental Outcomes Are Similar Despite Prematurity



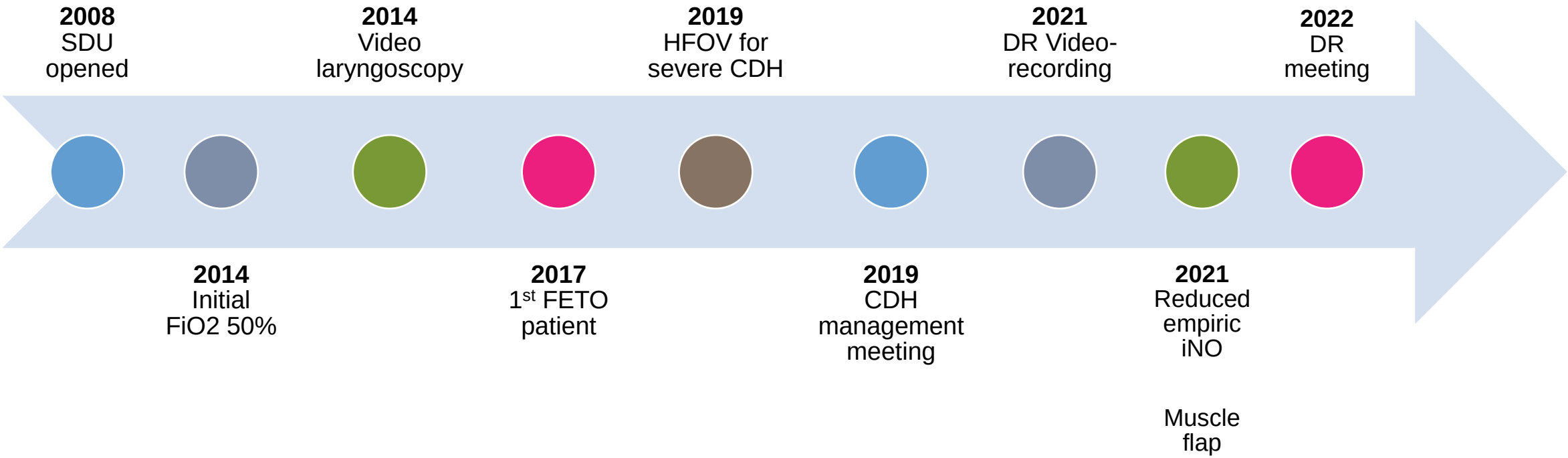
Bayley Scales of Infant and Early Development III, IV

Assessments at 6, 12, and 24 months

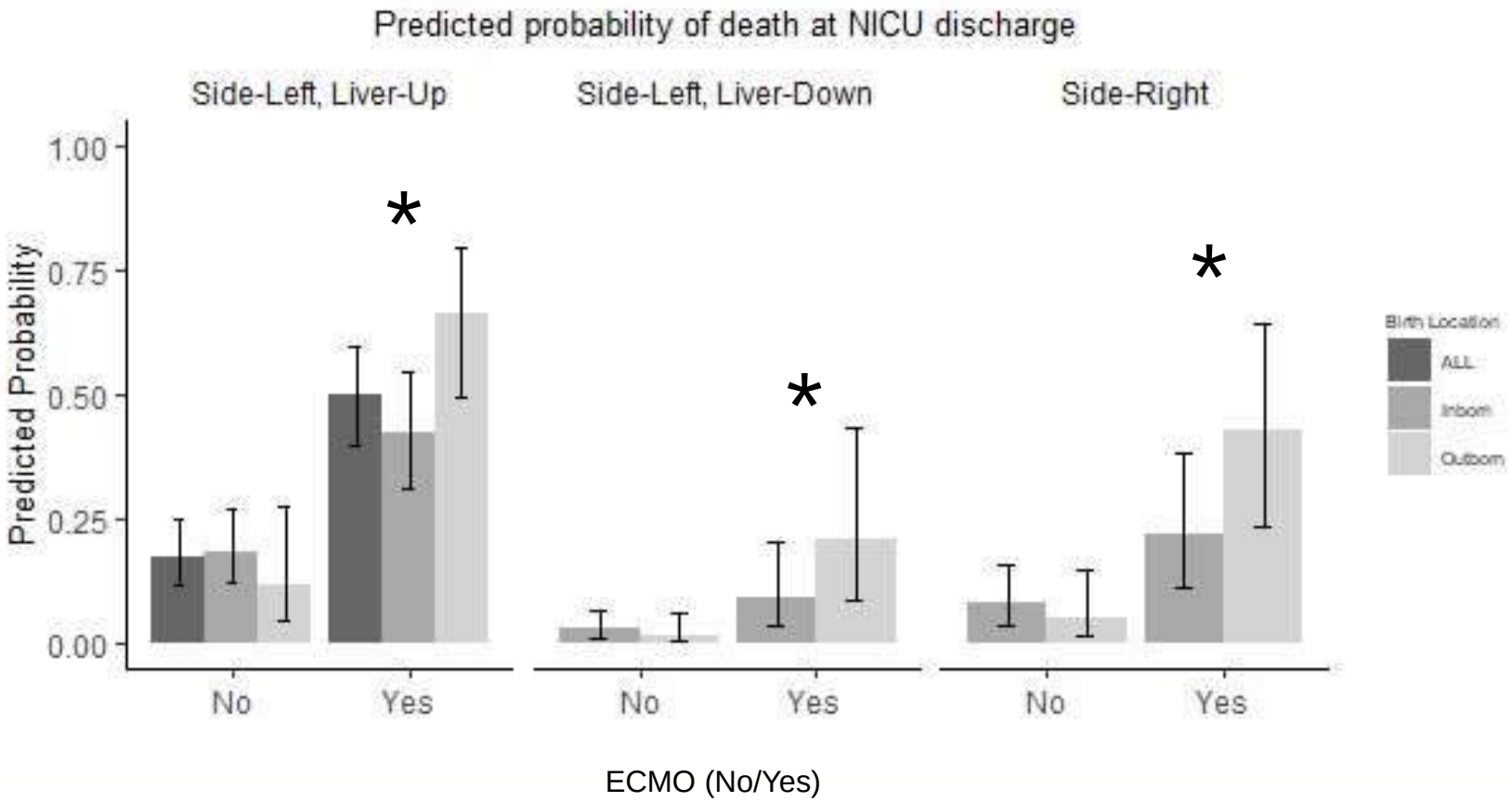
Scores expressed as Mean (SD)

Garbose Family Special Delivery Unit

Timeline of Changes in CDH Care

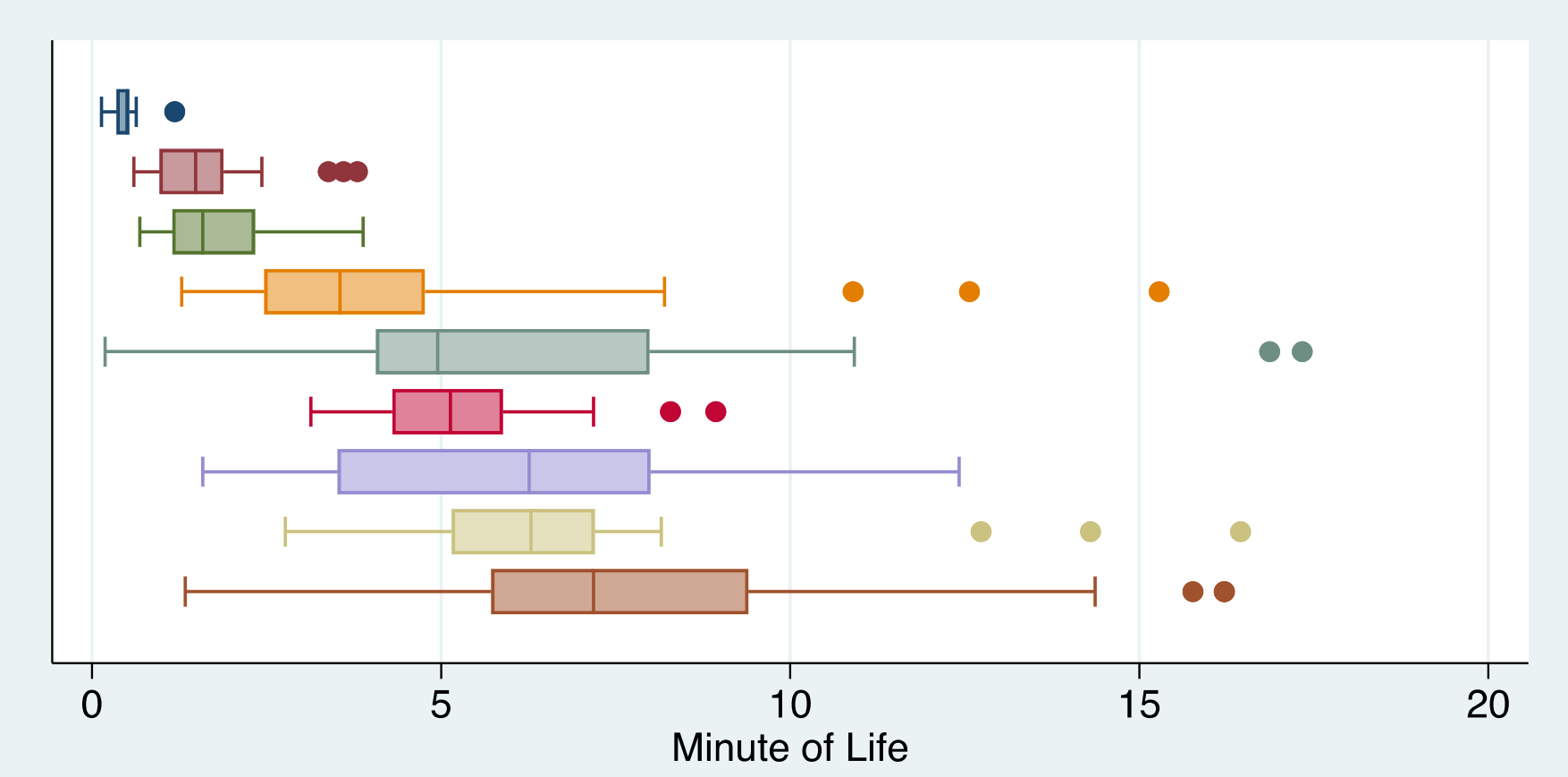


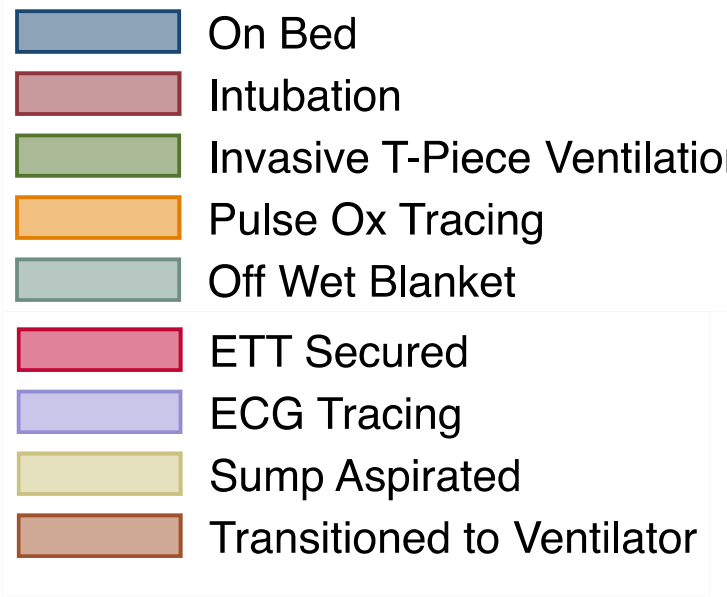
ECMO Survival Improved With SDU Delivery



Delivery in the Garbose Special Delivery Unit (SDU) moderates the association between ECMO and survival after controlling for significant covariates: Survival is improved among children who are delivered in the SDU and who require ECMO

Golden Hour Video Review of CDH Resuscitation

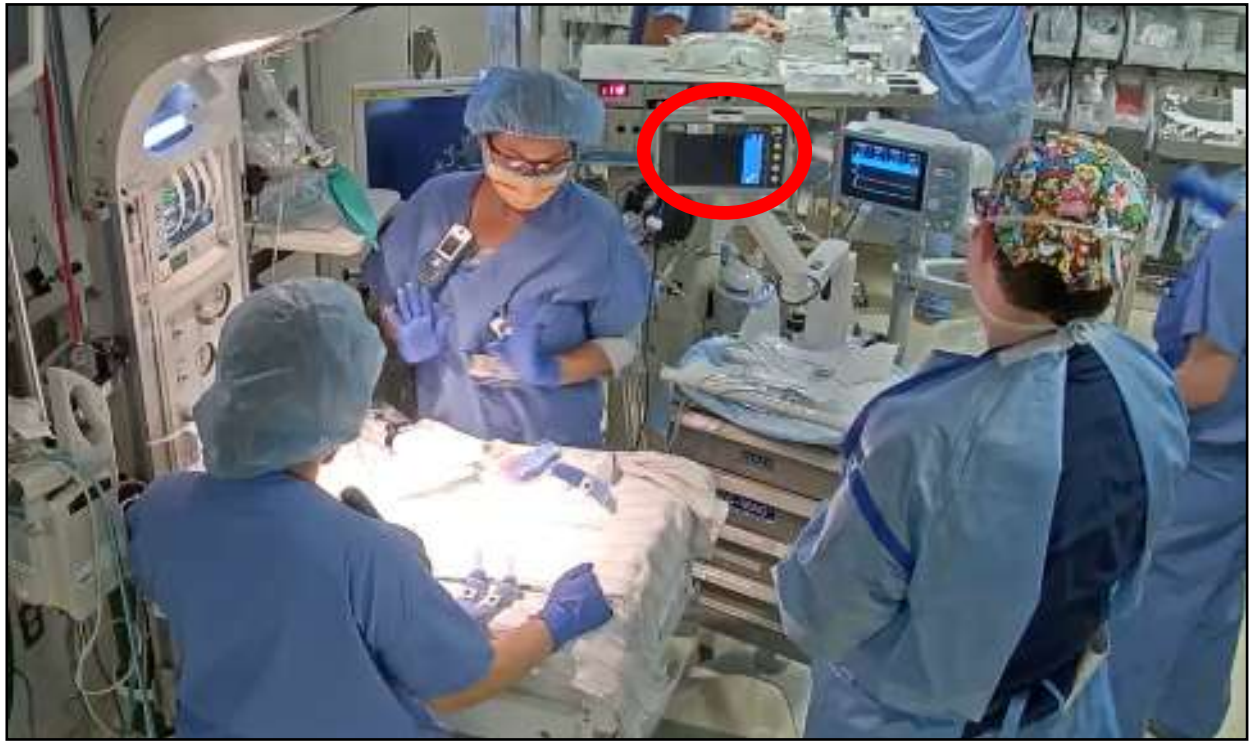


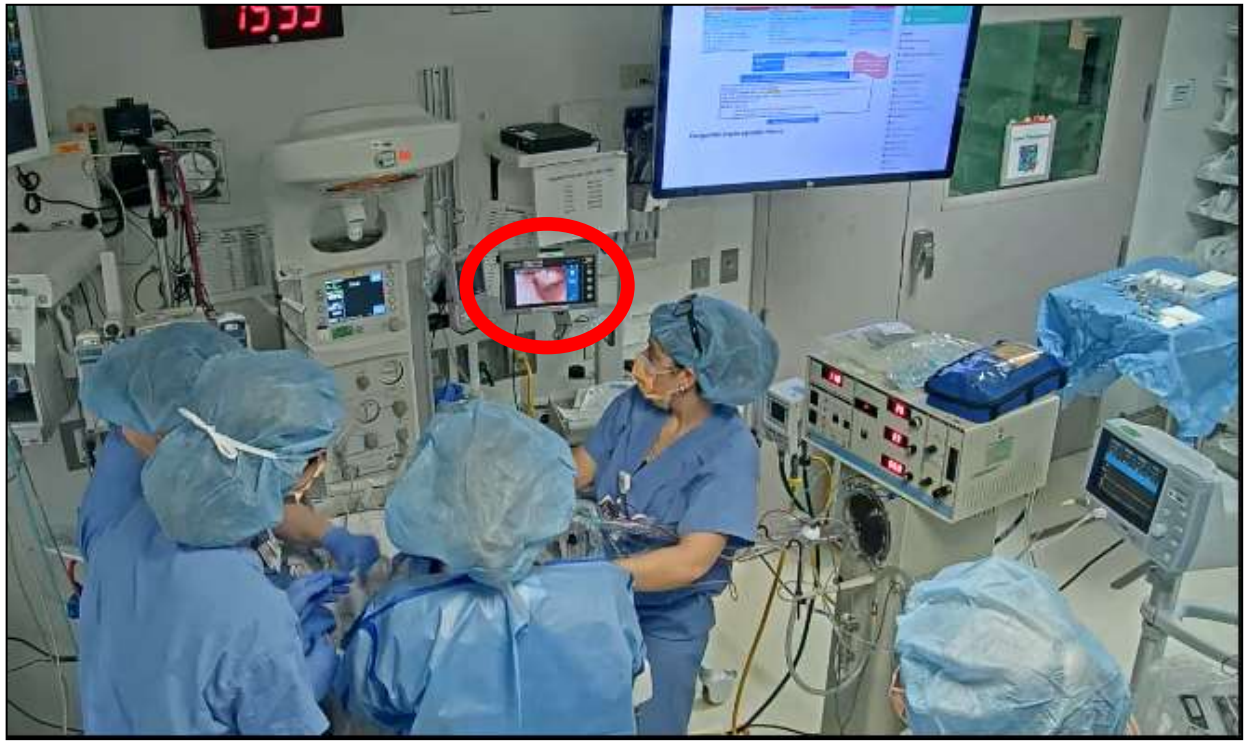


DR= Delivery Room, CDH= Congenital Diaphragmatic Hernia,
ETT= Endotracheal Tube, ECG= Electrocardiogram

Figure 1: Timing of DR Interventions for Neonates with CDH by Minute of Life.
Box plot demonstrating the median and interquartile range summarized across all 31 babies for each completed task

New SDU Set up





Children's Hospital of Philadelphia

Early Management

Immediate intubation

Inspired oxygen to start at 50%

Goal pre-ductal O_2 saturation > 85%

First 24 hours highest risk ECMO

Gentle Ventilation

- Permissive hypercapnia
- Tolerate CO_2 60s
- Small breaths, rapid rate

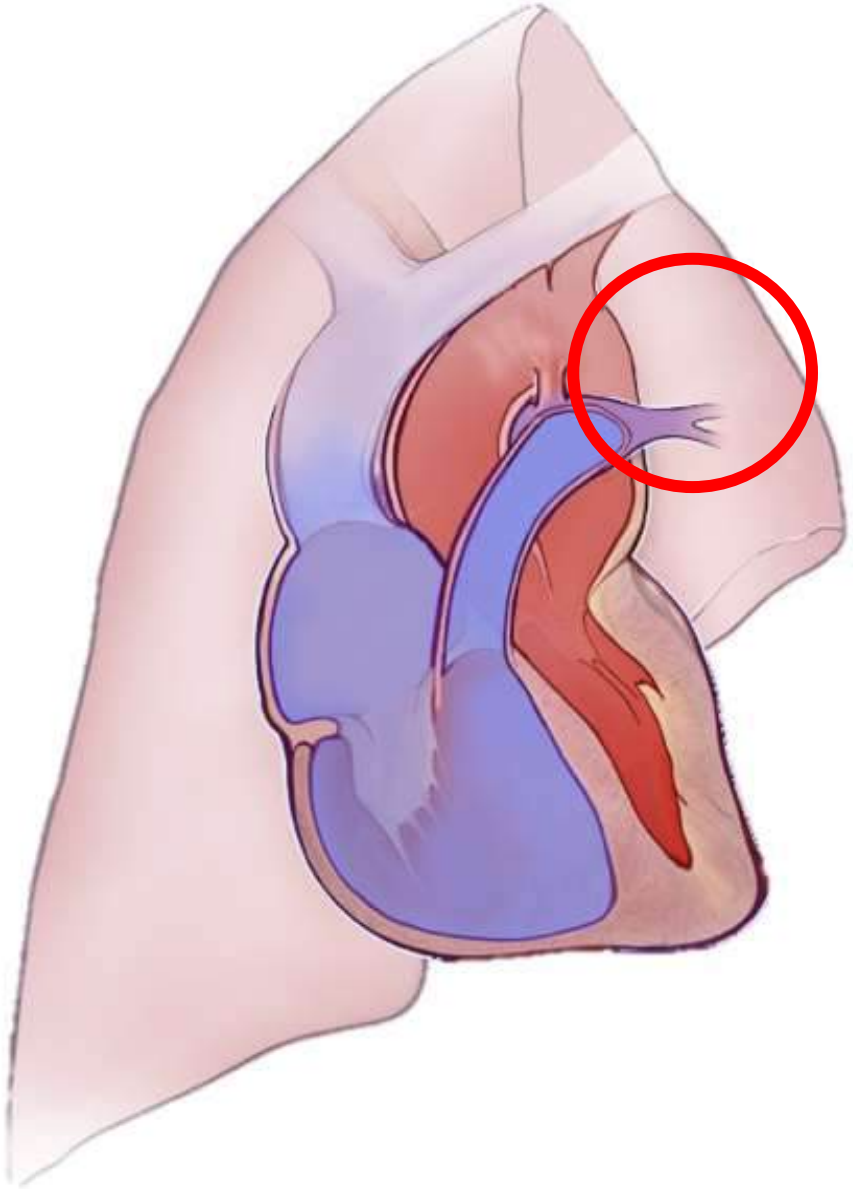
Children's Hospital of Philadelphia
NEOSURGICAL UNIT

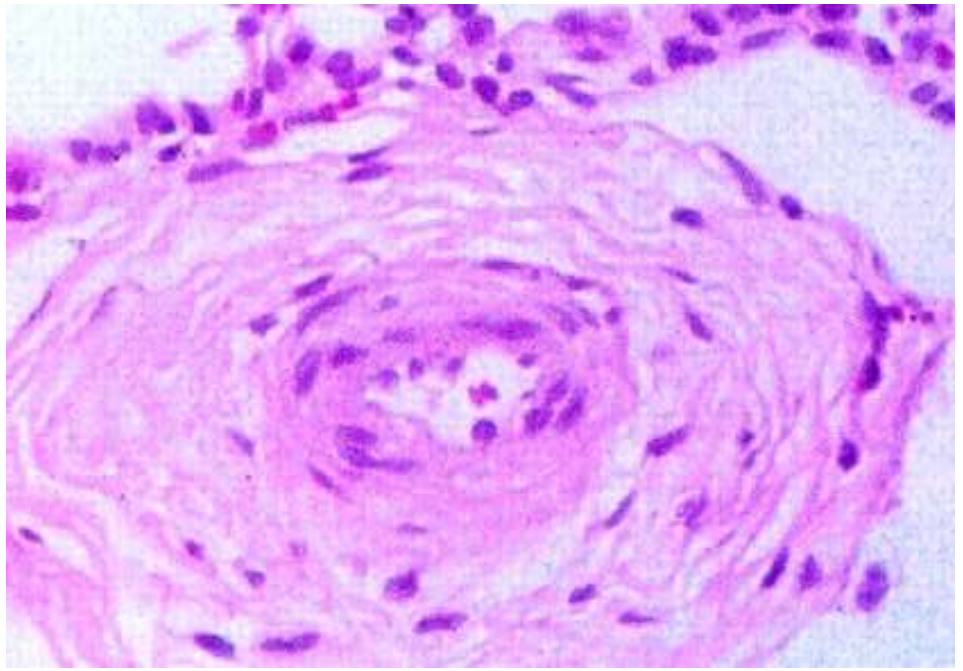
What Happens in the NICU ……..

Pre-Surgery → **Surgical Repair** → **Post-Repair**

Children's Hospital of Philadelphia

Why do babies have Pulmonary Hypertension?



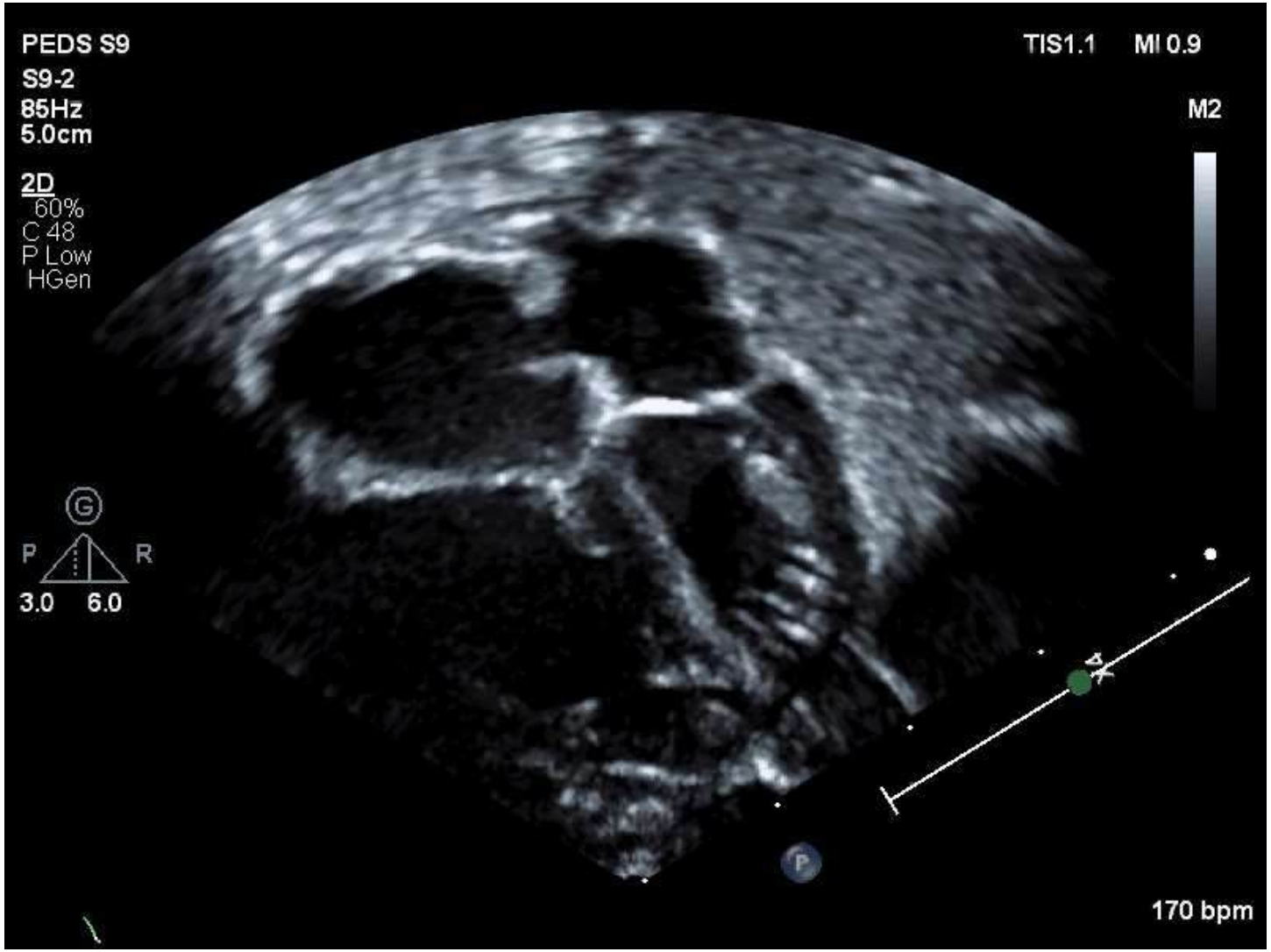


1. pulmonary hypoplasia with decreased alveolarization
2. hyper-muscularization of the vessels
3. decreased cross- sectional area of the vascular bed
4. altered vasoreactivity

Echocardiogram

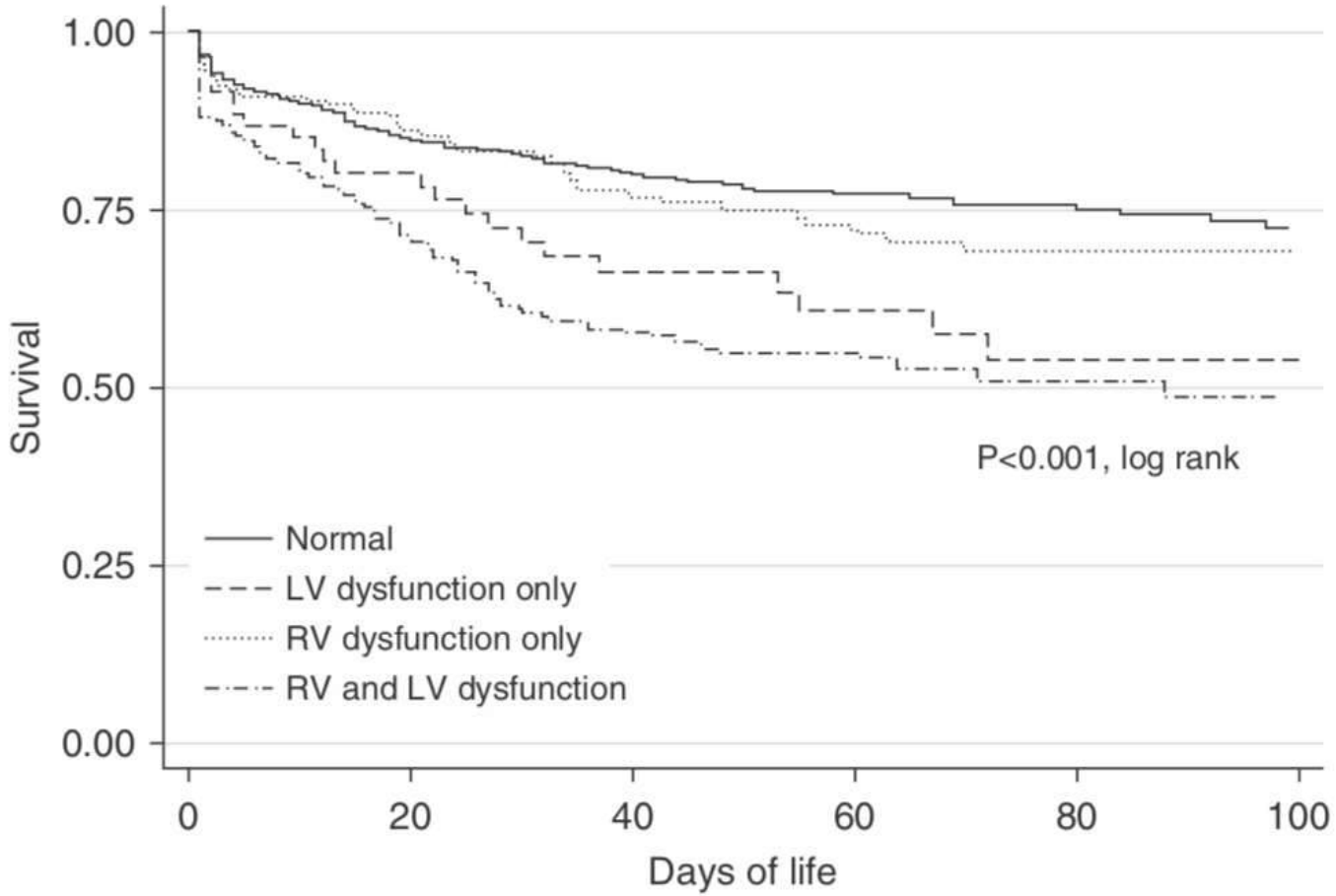
1. **Shunt**
    a. Ductal
    b. Atrial

2. **Ventricular Function**



Ventricular Dysfunction Is a Critical Determinant of Mortality in Congenital Diaphragmatic Hernia

Neil Patel[1], Pamela A. Lally[2], Florian Kipfmueller[3], Anna Claudia Massolo[4], Matias Luco[5], Krisa P. Van Meurs[6], Kevin P. Lally[2], and Matthew T. Harting[2]; for the Congenital Diaphragmatic Hernia Study Group

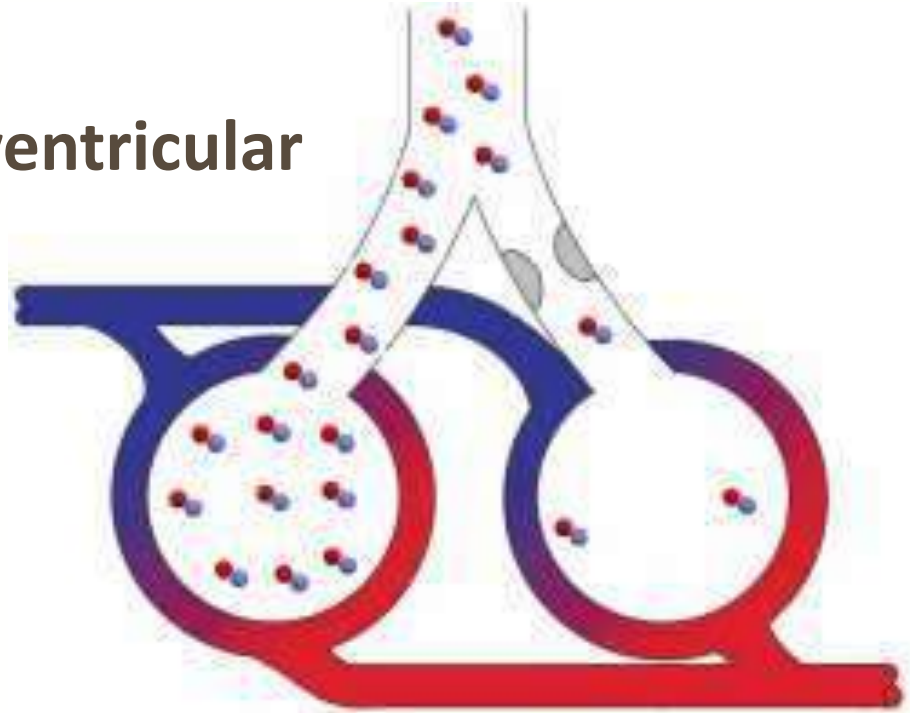


Am J Respir Crit Care Med, 2019

Selective use of iNO for CDH

2011 – 2016:
95 of 131 patients with CDH (73%) were treated with iNO

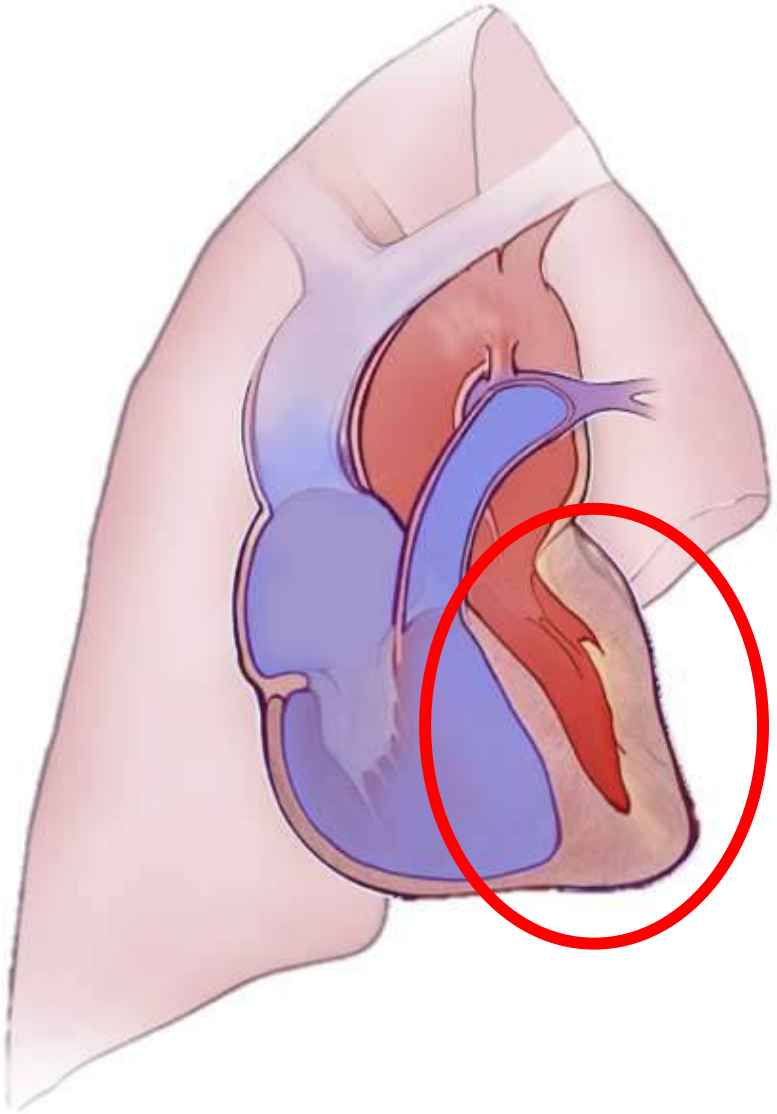
- **40% responders**
- **Non-responders** were **more** likely to have **left ventricular systolic dysfunction** on echocardiogram
  (27% vs 8%, *P* = .03)
- **Responders** were **less** likely to require **ECMO**
  (24% vs 50%, *P* = .02)



Inhaled pulmonary vasodilators (e.g. nitric oxide shown above) will preferentially cause vasodilation of better ventilated alveoli.

Lawrence, J Peds 2019

Why do babies have a small Left Ventricle?



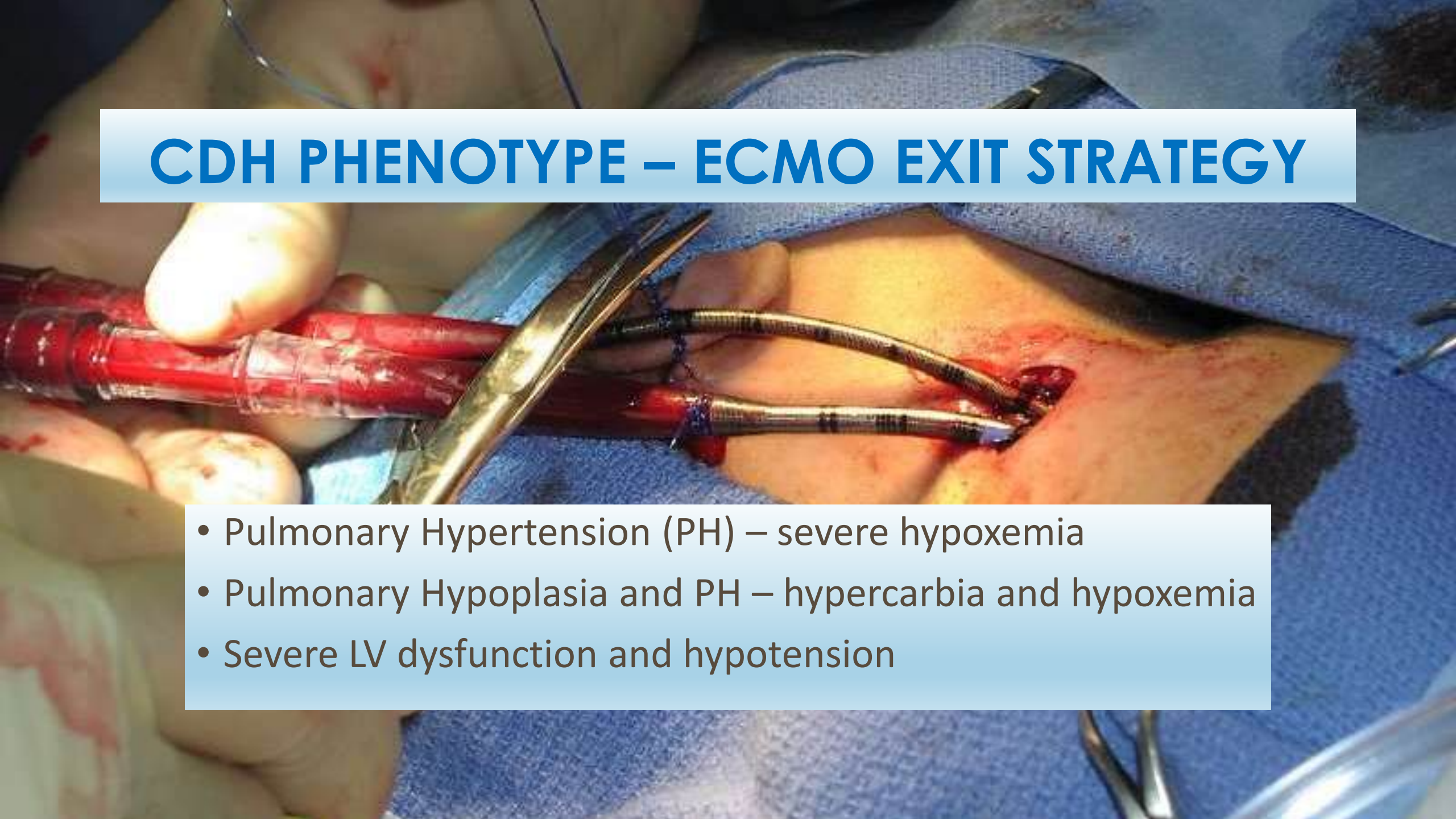
- the heart is displaced in utero by the herniated abdominal organs which causes altered ductus venosus flow with preferential streaming to the right atrium and chronic underfilling of the left ventricle, potentially contributing to left ventricular (LV) hypoplasia
- mechanical compression by herniated organs
- primary developmental abnormality - genetic basis

Children's Hospital of Philadelphia

CDH patients with left heart hypoplasia & LV dysfunction = highest odds mortality

	LV dys−/LHH− (N=37)	LV dys−/LHH+ (N=68)	LV dys+/LHH− (N=26)	LV dys+/LHH+ (N=51)	p-value
ECMO	1 (2.7)	12 (17.6)	9 (34.6)	21 (41.2)	<0.001
Mortality	0 (0)	3 (4.4)	5 (19.2)	15 (29.4)	<0.001

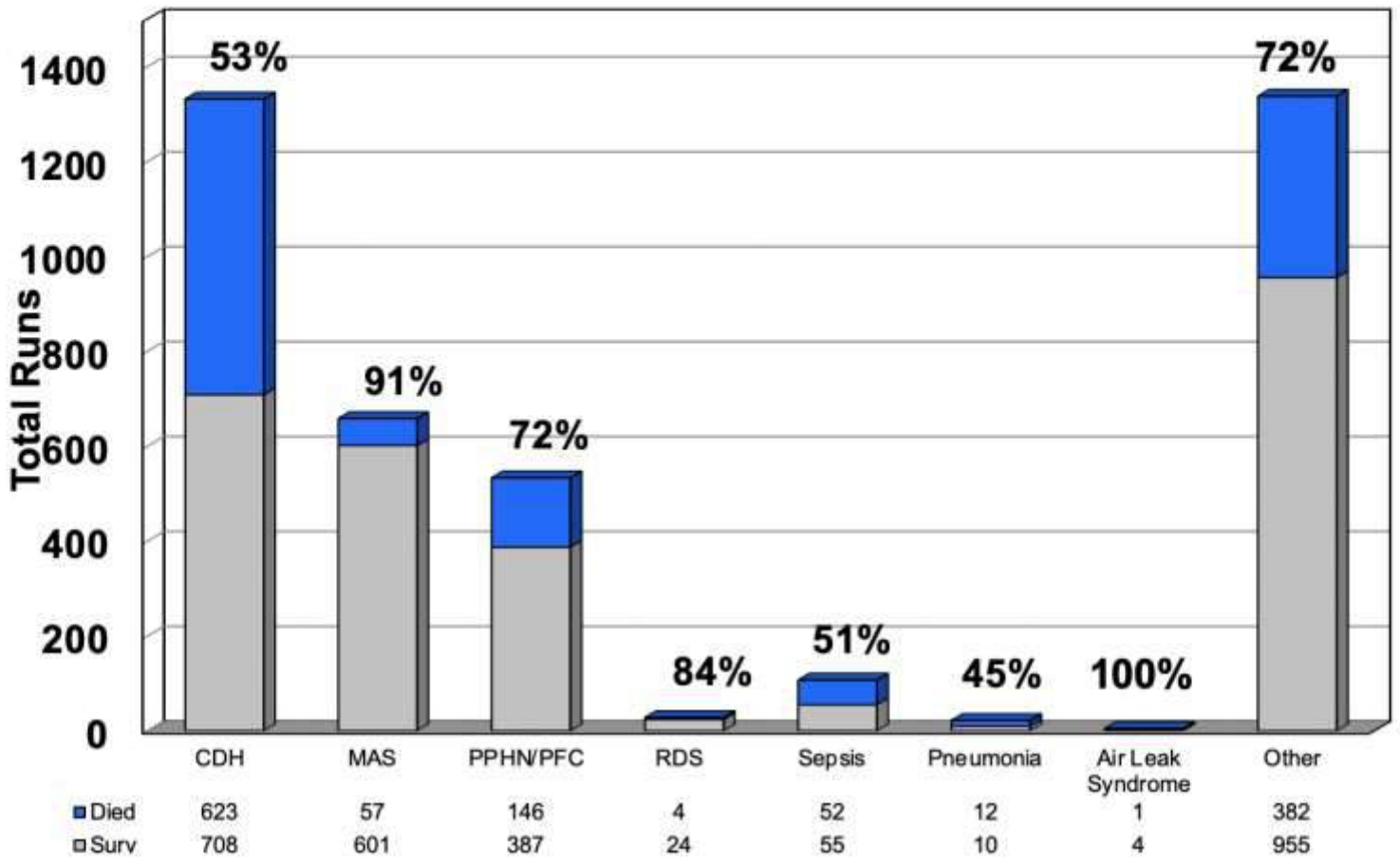
J Pediatr. 2024 Aug;271:114061



CDH PHENOTYPE – ECMO EXIT STRATEGY

- Pulmonary Hypertension (PH) – severe hypoxemia
- Pulmonary Hypoplasia and PH – hypercarbia and hypoxemia
- Severe LV dysfunction and hypotension

Neonatal Diagnoses and Survival since 2015

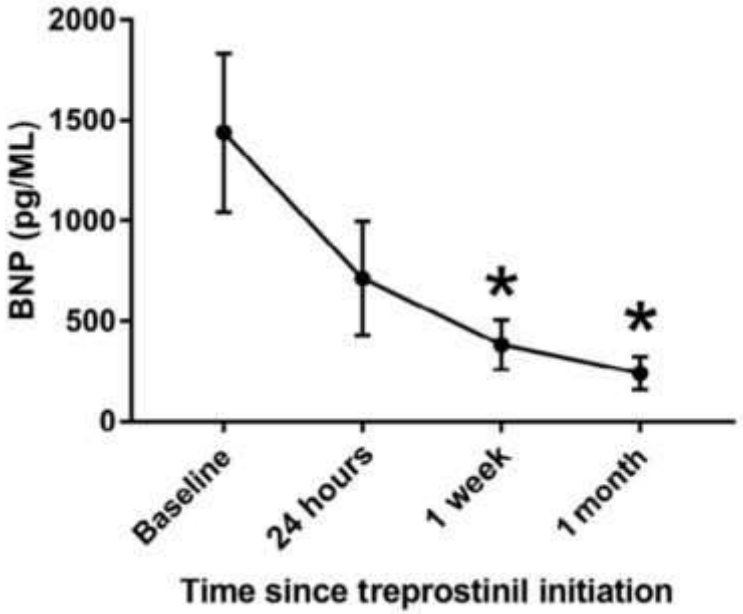


Treprostinil improves PH in severe CDH

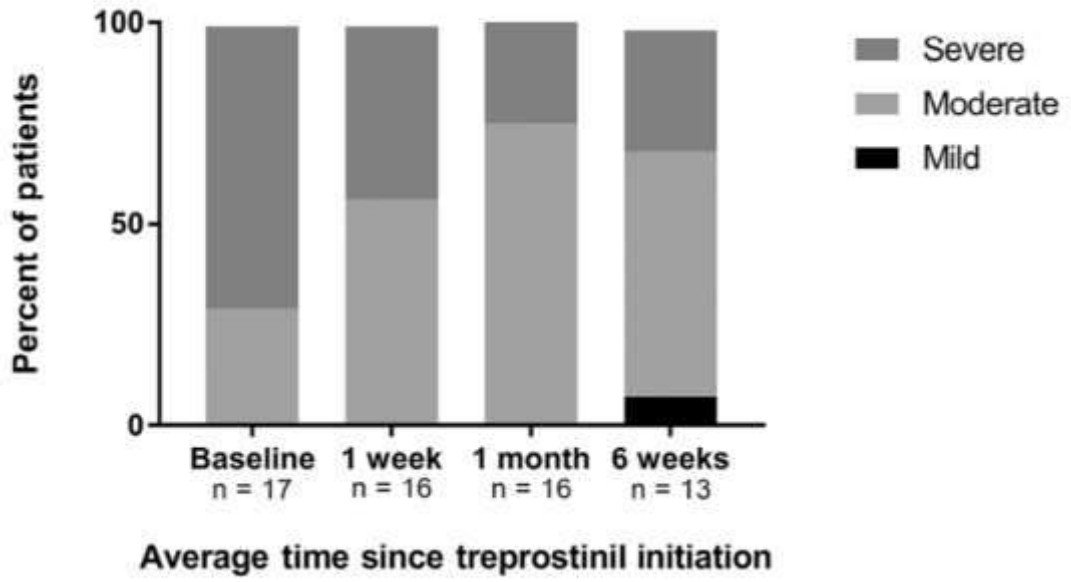
- **17 infants severe PH:** started ~37 days of age, duration 54.5 days
- 13/17 required ECMO: 5 before ECMO, 4 on ECMO to assist decannulation, 4 for persistent PH after ECMO
- BNP, ECHO improved
- No complications (hypotension, thrombocytopenia, pulmonary edema)
- 11/17 survived, 4 discharged on treprostinil

Lawrence et al. *J Pediatr* 2018

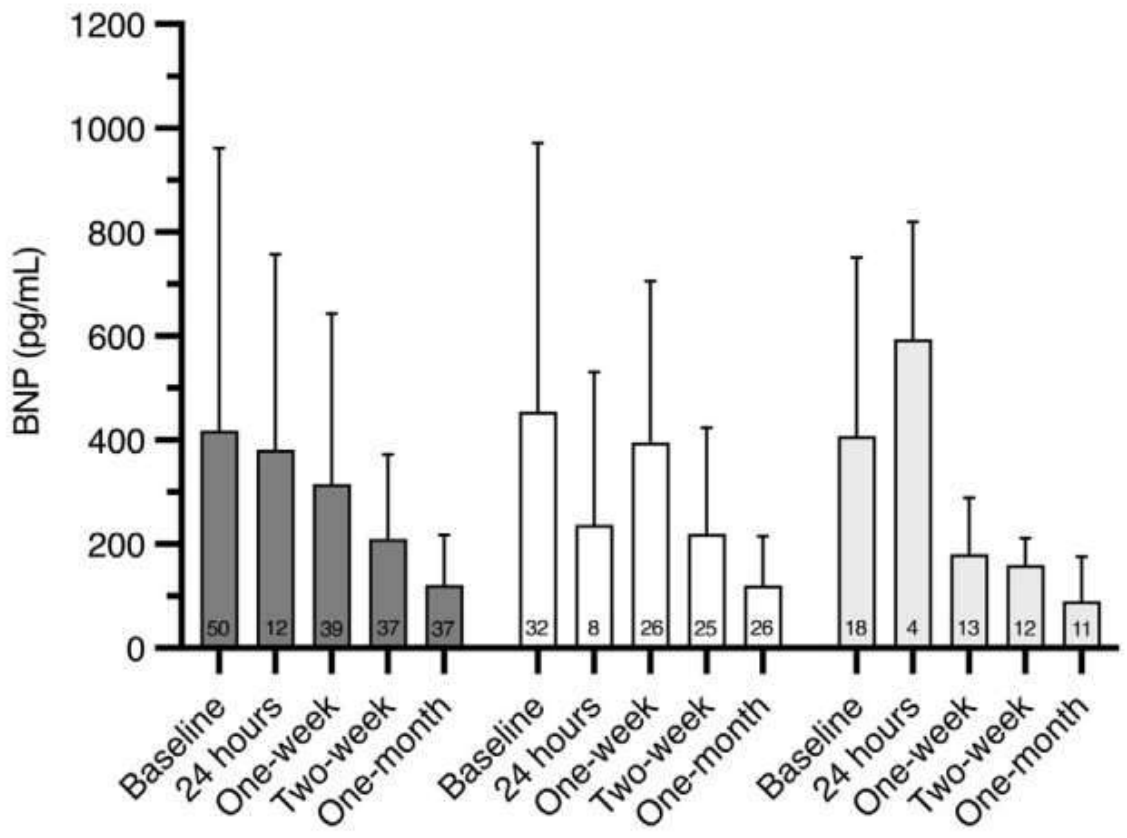
BNP

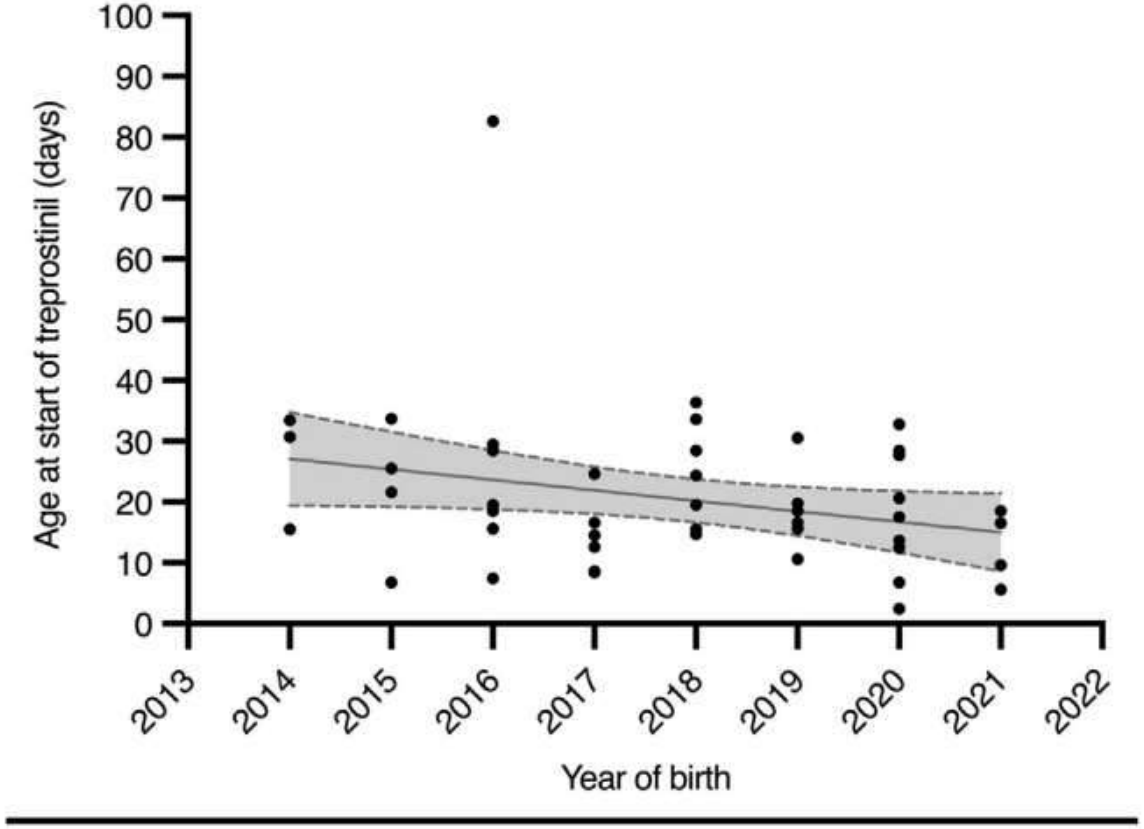


Echo PH severity



Treprostinil improves echo parameters, BNP and is now used earlier in course (51 patients)

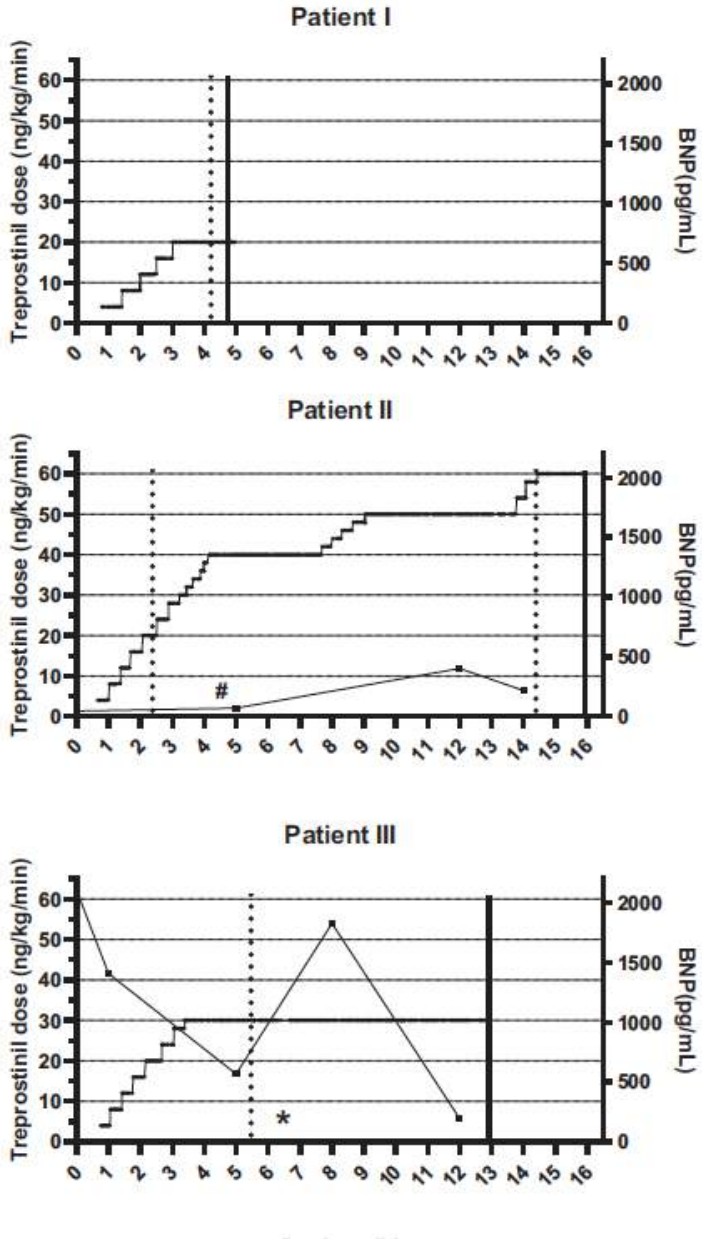




J Pediatr. 2023 Aug;259:113420

Treprostinil attains therapeutic levels on ECMO

- Four patients (CDH = 3) with pulmonary hypertension on ECMO
- Tresprostinil doses of 20-58 ng/kg/min reached therapeutic concentrations
- Improved RV function, reversed R to L shunt through PDA, decreased vasopressor support
- Decreased BNP
- No hemodynamic instability



PHARMACOTHERAPY Volume 40, Number 10, 2020

Right Ventricular Strain, Brain Natriuretic Peptide, and Mortality in Congenital Diaphragmatic Hernia

Catherine M. Avitabile[1,2], Yan Wang[1], Xuemei Zhang[3], Heather Griffis[3], Sofia Saavedra[1], Samantha Adams[4], Lisa Herkert[4], David B. Frank[1,2], Michael D. Quartermain[1,2], Natalie E. Rintoul[2,5], Holly L. Hedrick[4,6], and Laura Mercer-Rosa[1,2]

- CHOP 220 infants with 460 BNP-echocardiogram pairs preop, post op (<1wk), and in recovery (>1wk)
- Strain improved after repair
- Higher BNP associated with worse strain in recovery
- BNP and strain associated with ECMO
- Higher BNP in recovery associated with mortality

AnnalsATS Volume 17 Number 11 | November 2020

Table 5. History of ECMO was associated with abnormal BNP/strain after CDH repair

Dependent Variable (after Repair)	Predictor	Odds Ratio (95% CI)	*P* Value
BNP	ECMO	2.27 (1.05–4.76)	0.038
GLS	ECMO	2.86 (1.27–6.25)	0.013
FWS	ECMO	4.17 (2.13–7.69)	<0.0001

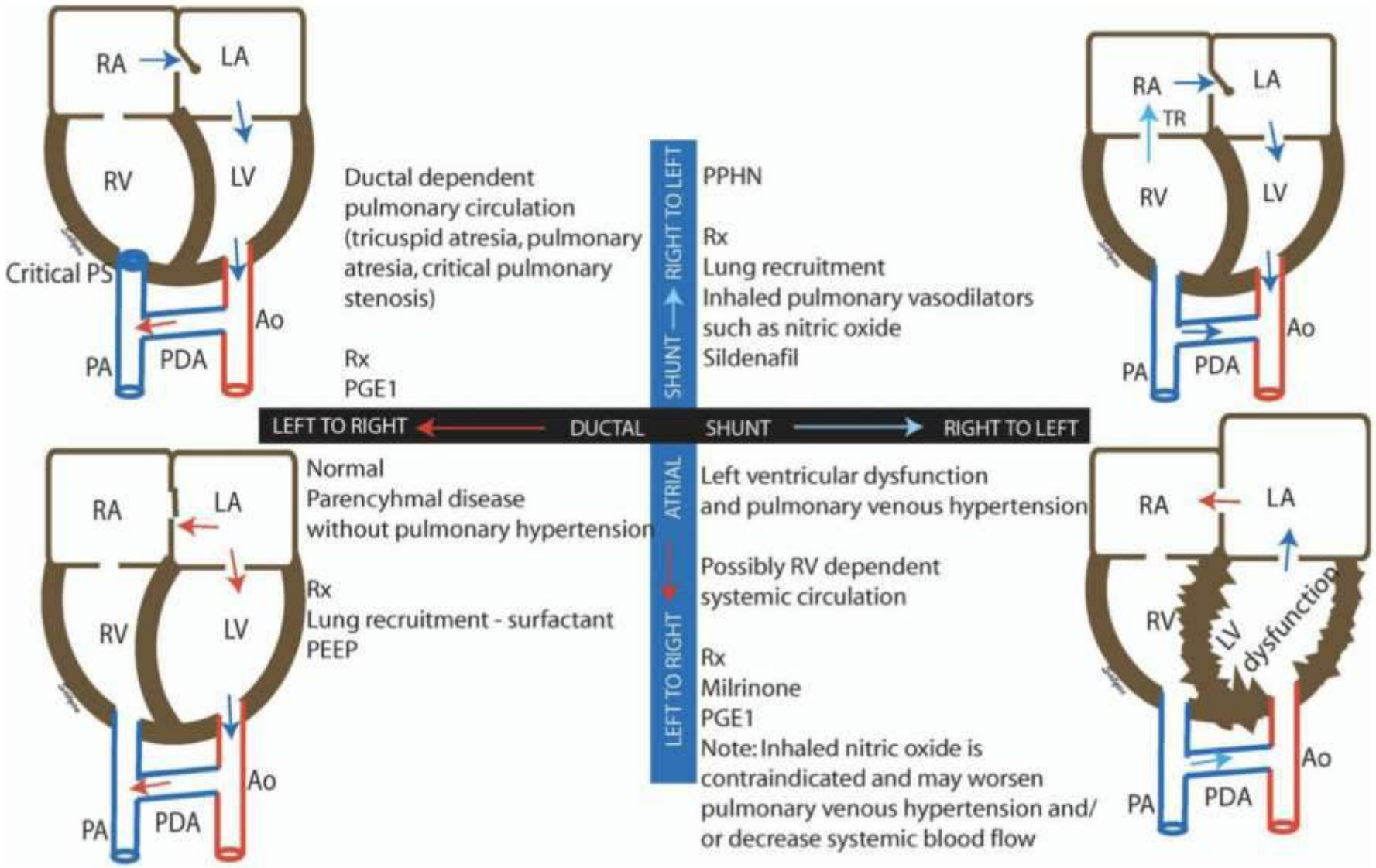
Definition of abbreviations: 95% CI = 95% confidence interval; BNP = brain-type natriuretic peptide; CDH = congenital diaphragmatic hernia; ECMO = extracorporeal-membrane oxygenation; FWS = free-wall strain; GLS = global longitudinal strain.

Table 7. Strain abnormalities in deceased patients versus survivors

	Abnormal GLS	Abnormal FWS
After repair*		
Deceased, *n* = 10	10 (100%)	10 (100%)
Alive, *n* = 134	103 (77%)	71 (57%)
P value, exact logistic regression	0.29	0.12
Recovery		
Deceased, *n* = 8	8 (100%)	8 (100%)
Alive, *n* = 122	88 (72%)	63 (52%)
P value, exact logistic regression	0.29	0.097

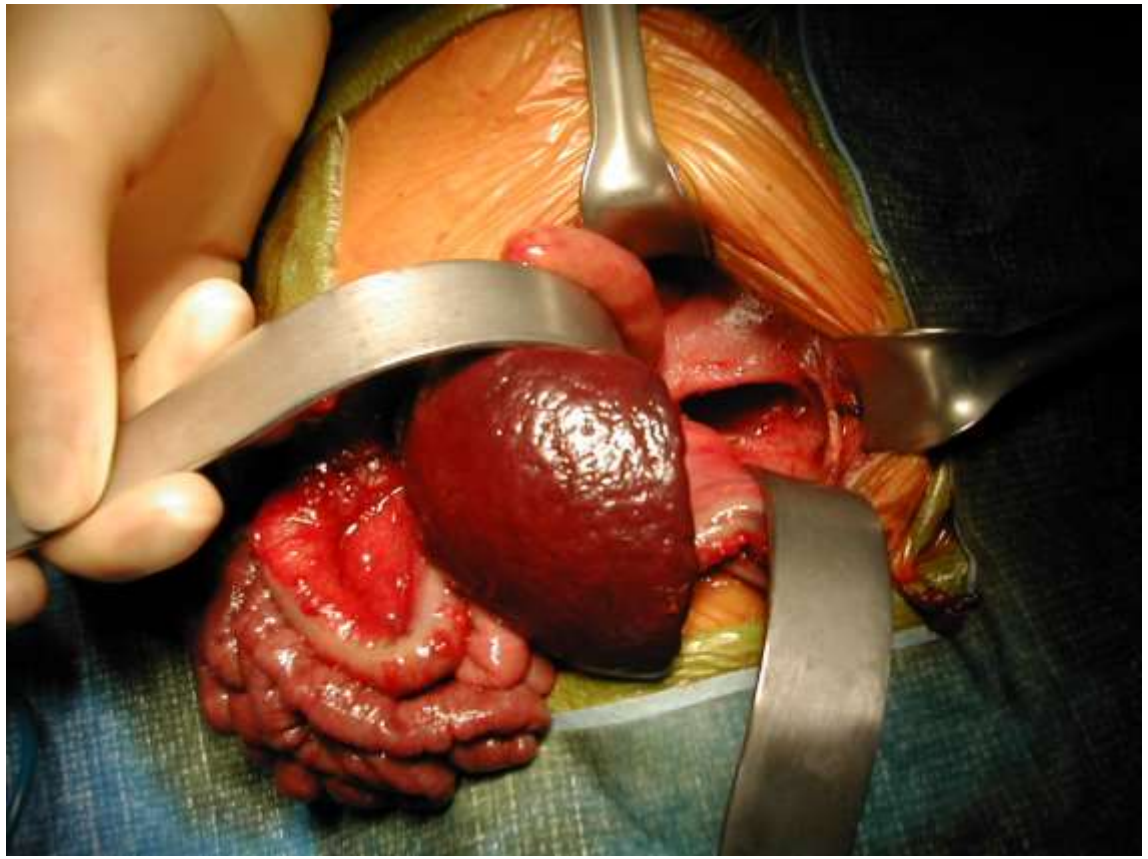
Definition of abbreviations: FWS = free-wall strain; GLS = global longitudinal strain.
*Includes patients with abnormal strain in either immediate postoperative or recovery periods.

Cardiac Phenotype directs therapeutic choices



Seminars in Perinatology, 2014

Surgical Repair of CDH



- Timing
- Location
- Primary repair
- GoreTex patch vs muscle flap
- Complications

Synthetic Patch Repair

PTFE most common

- Durable
- Does not grow
- Challenging if infected
- Recurrence
- Skeletal deformity

Journal of Pediatric Surgery Case Reports 90 (2023) 102583

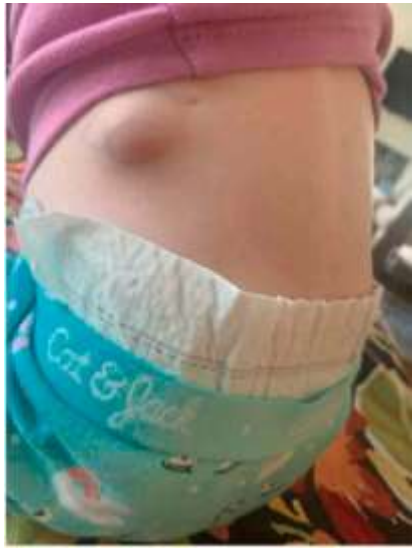
Contents lists available at ScienceDirect

Journal of Pediatric Surgery Case Reports

journal homepage: www.elsevier.com/locate/epsc

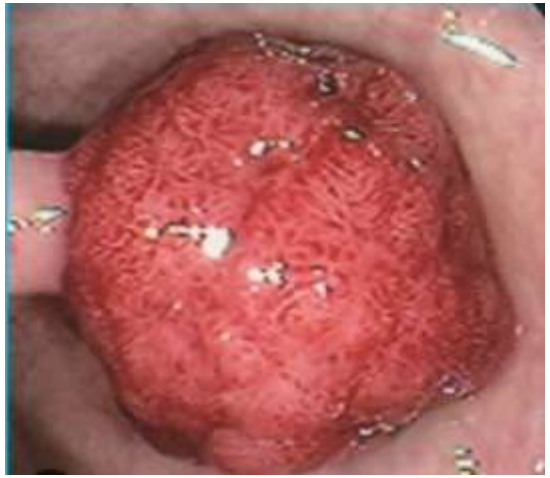
Synthetic patch infection after congenital diaphragmatic hernia repair: A case series

Sabrina J. Flohr[a], Sierra D. Land[a], Holly L. Hedrick[a,b], Natalie E. Rintoul[a,c], Sanjeev K. Swami[d], Dustin D. Flannery[c,*]

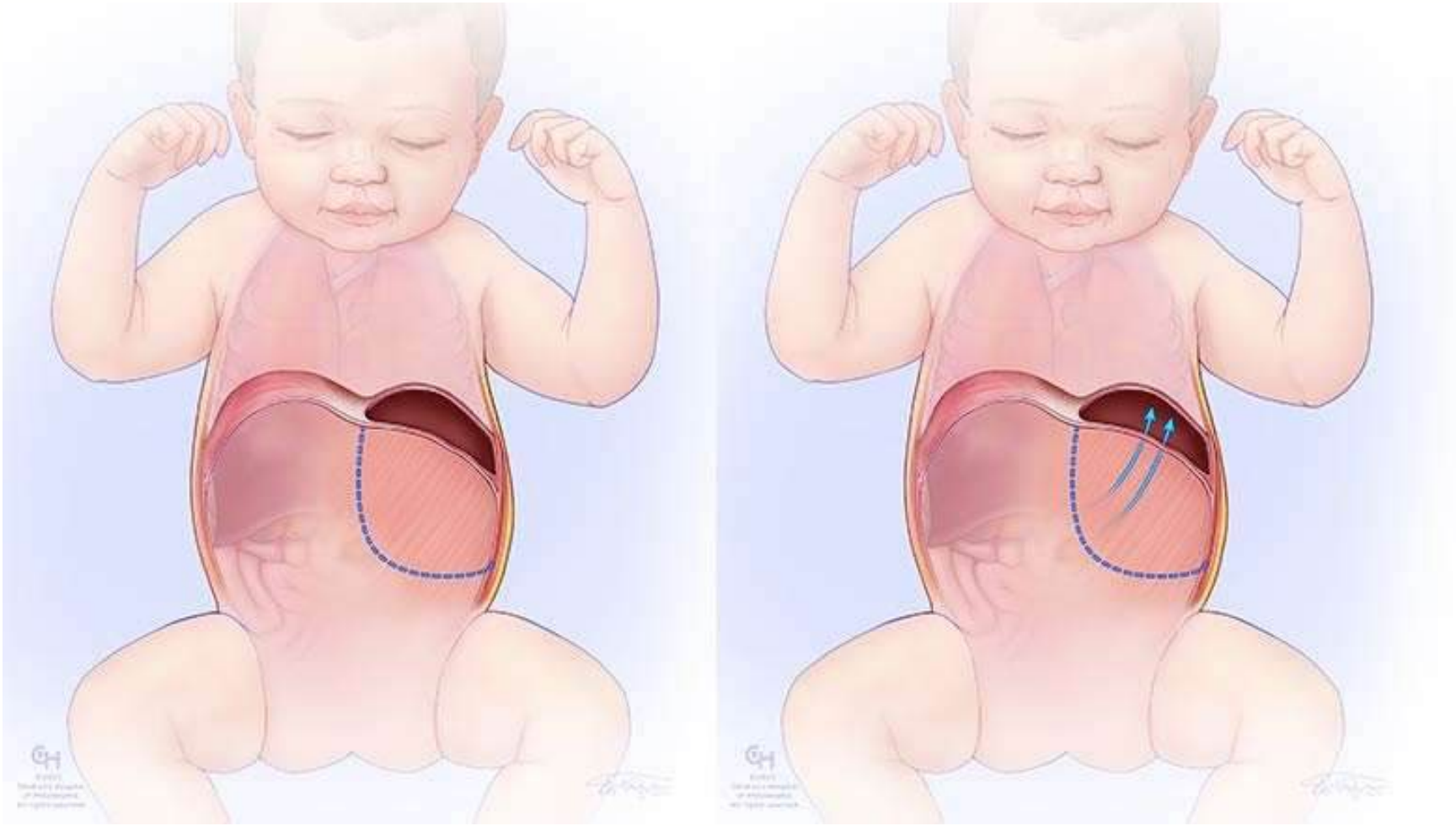


Extracorporeal membrane oxygenation during birth hospitalization	
Yes	4 (40%)
No	6 (60%)
CDH side	
Left	9 (90%)
Right	1 (10%)
Length of initial birth hospitalization (days), median [IQR]	141 [100, 214]
GA at birth (weeks), median [IQR]	37.5 [35, 38]
Timing of suspected/confirmed patch infection diagnosis from date of birth (days), median [IQR]	400 [90, 1625]
Timing of suspected/confirmed patch infection diagnosis from date of repair (days), median [IQR]	383 [124, 1428]
Infection prior to first discharge	3 (30%)
Disposition of patch infection admission	
Deceased	2 (20%)
Discharged	8 (80%)
Removal of infected patch*	7 (70%)
Replaced with biologic patch	1 (14.3%)
Replaced with muscle flap	2 (28.6%)
Not replaced	4 (57.1%)

Footnotes: CDH (congenital diaphragmatic hernia); GA (gestational age); IQR (interquartile range).

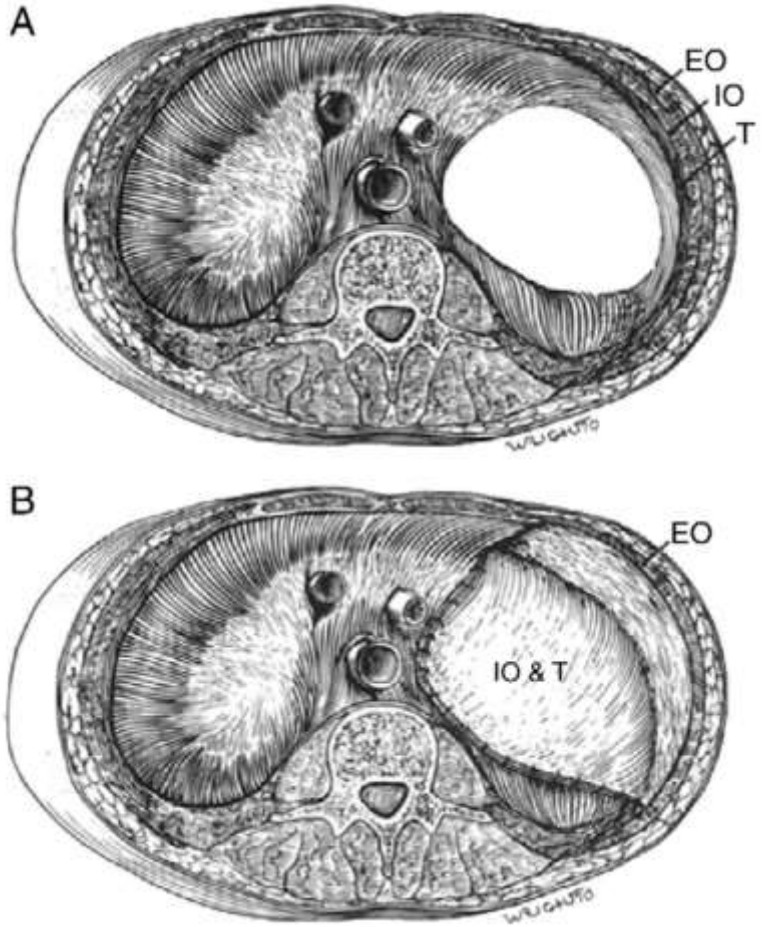


Muscle Flaps for CDH

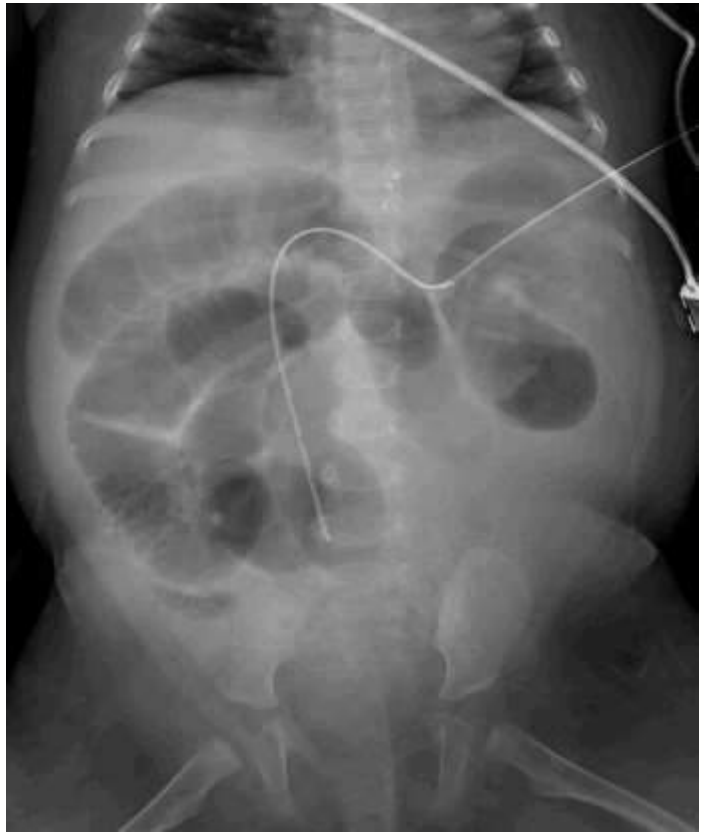


Muscle Flap Repair

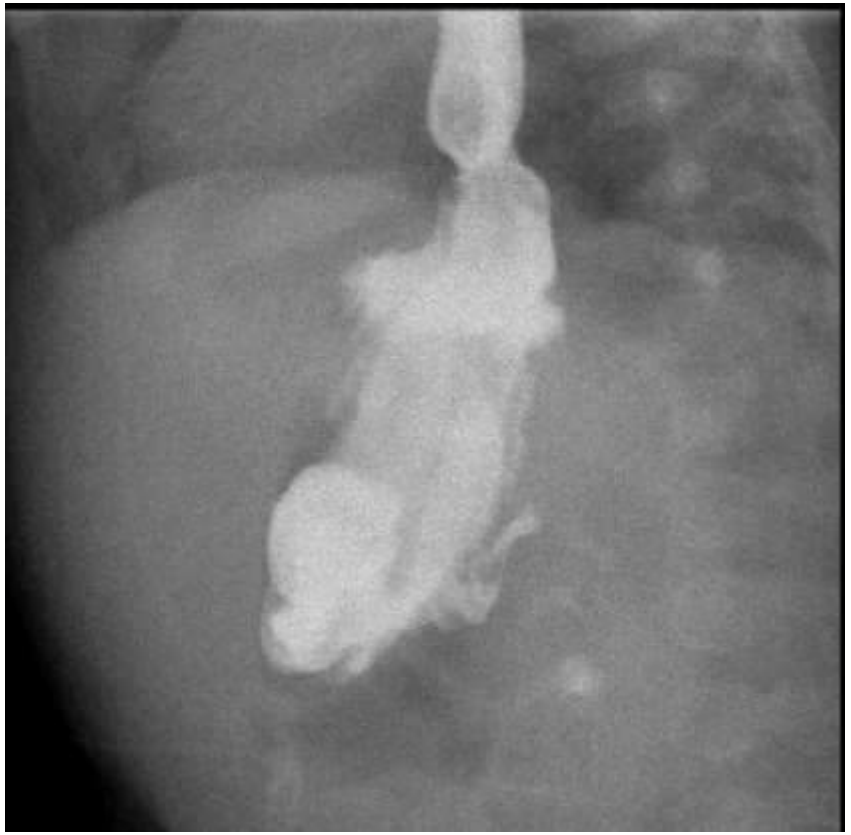
- Latissimus dorsi reported for staged repairs, impractical for early neonatal repair. (JPS 2003;38:296-300, JPS 2002;37:367-70, JPS 1983;18:560-3)
- 1962 Meeker and Snyder describe use of abdominal wall muscle flap using a subcostal incision and the entire upper edge of the abdominal wall to close the defect “like a garage door”. (JPS 1962;104:196-203)
- 1971 Simpson and Gossage clear description of split abdominal wall muscle flap using both transversalis and internal oblique. (JPS 1971;6:42-4)



Complications:



Small bowel obstruction



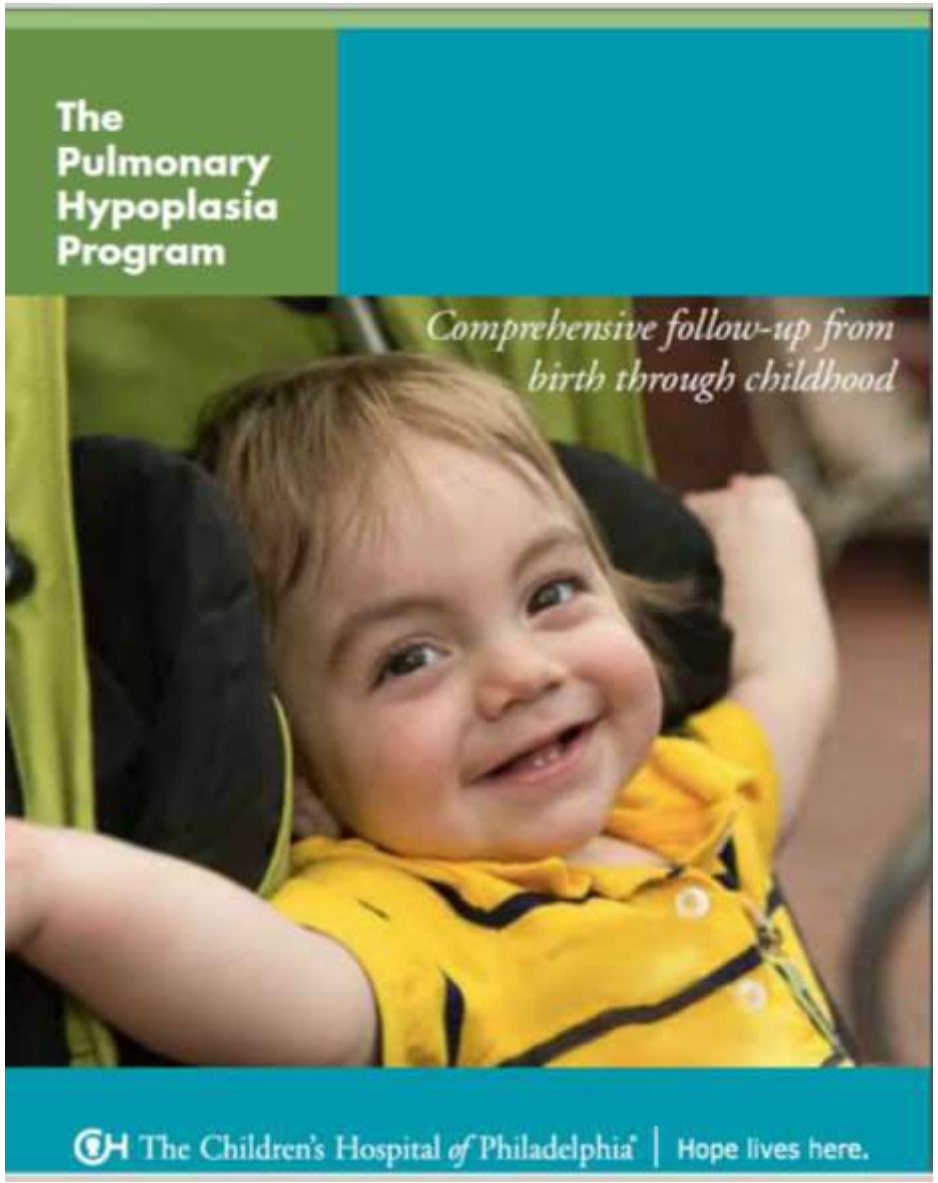
Hiatal hernia with severe GERD

Recurrence rates lower with native tissue

	Primary (n=174, 39.1%)	Patch (n=194, 43.6%)	Muscle Flap (n=75, 16.6%)	Muscle flap + Patch (n=2, 0.5%)
	Demographics			
Prenatal diagnosis, *yes*	115 (66.1%)	189 (96.4%)	74 (98.7%)	2 (100%)
Liver herniation, *yes*	41 (23.5%)	144 (73.5%)	61 (81.3%)	2 (100%)
D-type defect, *yes*	0 (0.0%)	15 (7.7%)	16 (21.3%)	2 (100%)
ECMO, *yes*	7 (4.0%)	70 (35.7%)	23 (30.6%)	2 (100%)
	Outcomes			
Follow up >6 months, *yes*	157 (90.2%)	183 (94.3%)	66 (88.0%)	2 (100%)
Time of follow up, *months**	24.0 [0.0, 104.0]	48.0 [0.0, 117.0]	12.0 [0.0, 84.0]	0.50 [0.0, 1.0]
Recurrence, *yes*	6 (3.4%)	22 (11.7%)	3 (4.0%)	0 (0.0%)
Median time to recurrence, *months**	6.97 [0.7, 104.0]	24.0 [5.3, 103.0]	24.7 [4.1, 45.1]	NA [NA, NA]

Percentages are expressed with column total as denominator. * Median [min, max].

Pulmonary Hypoplasia Program 2004



The Pulmonary Hypoplasia Program
Follow-up Appointment Schedule

Pulmonary Hypoplasia Program (PHP) appointment schedules are based on your child's needs, but typically occur at 6 months of age, 1 year, 2 years, 4 ½ to 5 years, 6 years and then every two years thereafter. Below is a breakdown of the specialists your child will likely see during each follow-up visit. Appointments in the PHP are designed to allow for visits with multiple specialists in one location. In most cases, any necessary testing can also be completed on the day of your appointment.

	6 months	1 year	2 years	4 ½ – 5 years	6 years, and every 2 years thereafter
Gen Surg	■	■	■	■	■
Pulmonary	■	■	■	■	■
Infant Pulmonary Function Test	■	■	■		
Neonatal	■	■	■	■	
Nutrition	■	■			
Social Work	■	■			
Cardiology	■	■			
ECHO/EKG	■	■			
Audiology	■	■	■	■	
Spirometry *(pulmonary function test)*					■

Phone Numbers: Pulmonary Hypoplasia Program 215-590-2733

General Surgery	215-590-2733	Nutrition	215-590-2733
Pulmonary	215-590-3749	Cardiology	215-590-4040
Neonatal Follow-up	215-590-2183	Audiology	1-800-551-5480

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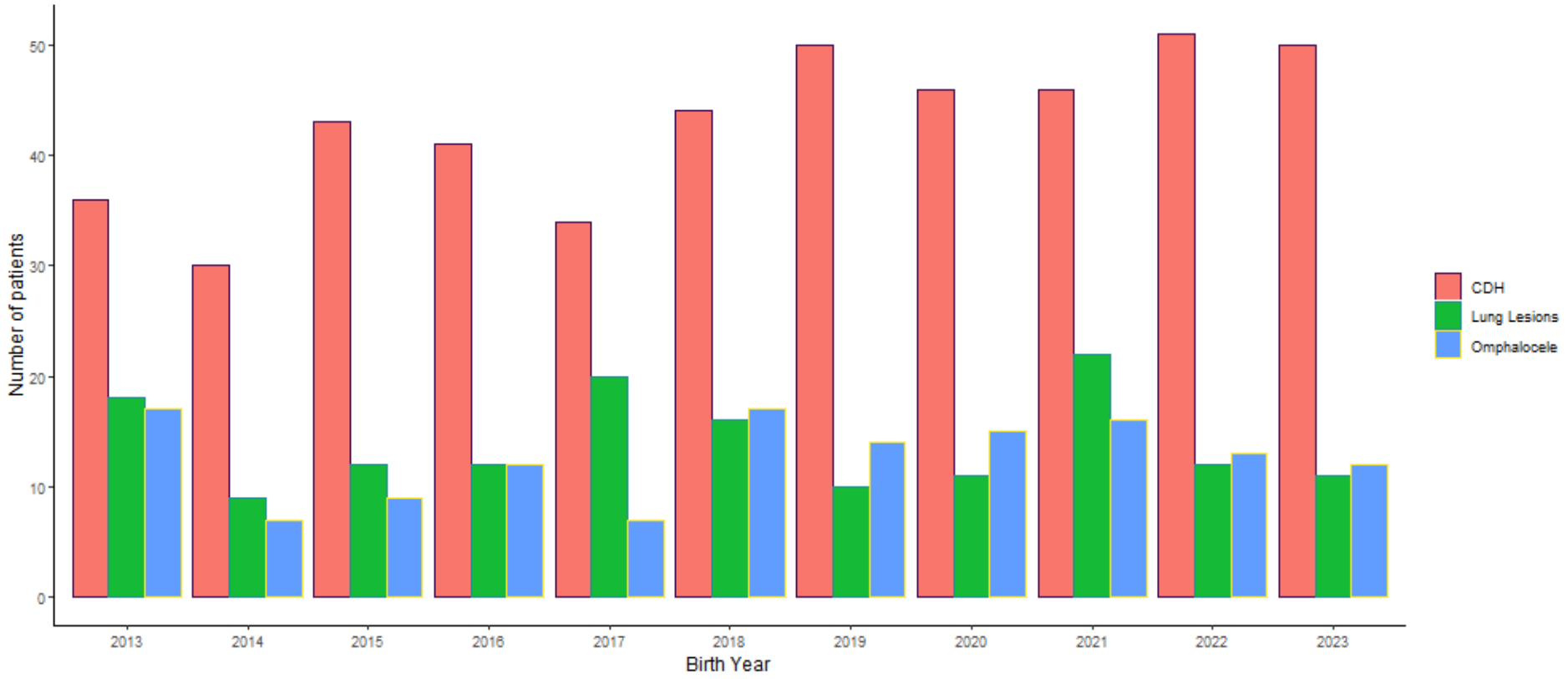
Long Term Follow-Up

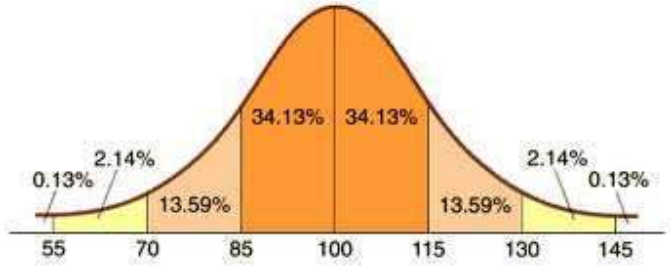
The Pulmonary Hypoplasia Program (PHP) registry > 1,000 patients

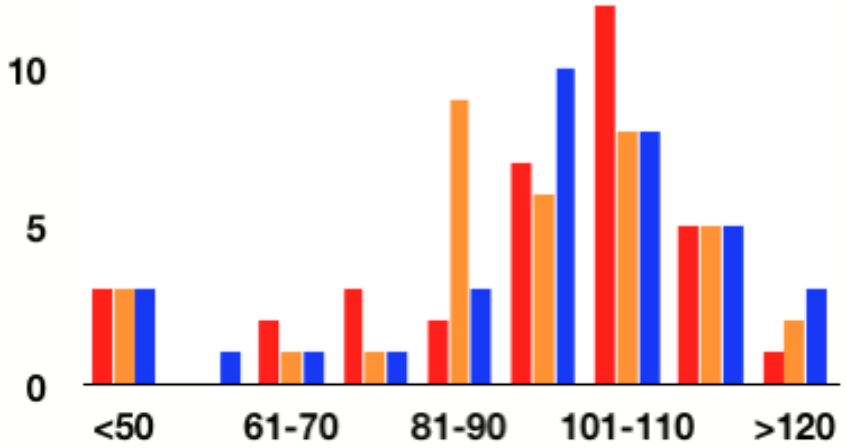


CDH Pre-K Outcomes

Danzer et al. presented 2015

Intelligence Distribution:
The "Normal" Curve

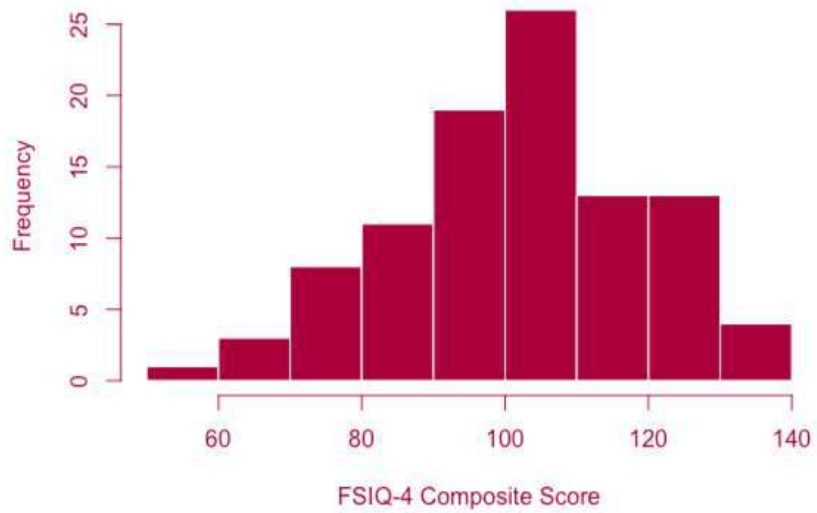




N = 36

Significantly more CDH children had ***borderline (17%)*** and ***extremely low (17%)*** scores in at least one domain compared to normative cohorts (7% and 1%, respectively; ***P<0.03***)

School Age (8-13 year old): Neurodevelopmental Results



	Congenital Diaphragmatic Hernia (N=59)	Giant Omphalocele (N=14)	Lung Lesion (N=20)	Mixed/Other (N=7)	Overall (N=100)
Verbal Comprehension Index					
Mean (SD)	104 (± 16.6)	106 (± 20.2)	109 (± 13.0)	104 (± 16.5)	105 (± 16.3)
Missing	2 (3.4%)	0 (0%)	0 (0%)	0 (0%)	2 (2.0%)

On average, scores met developmental milestones

- No statistically significant difference using variable WASI-II or WJ-III measures
- Mean FSIQ-4 amongst children exposed to ECMO = 101 ± 16 vs 102 ± 17 (p = 0.61)

CDH Summary

Details of initial hospitalization have lasting consequences

Long term follow up is critical to capture and mitigate morbidities

Integration of teams – collaboration is key

CARDIOLOGY 2025

Children's Hospital of Philadelphia
Richard D. Wood Jr. Center for Fetal Diagnosis & Treatment

Next Steps

CHOP CDH Team

- Anesthesia: Rebecca Isserman, Olivia Nelson, Kha Tran
- Cardiology – Kate Avitabile, PH Team
- Center for Fetal Diagnosis and Treatment –N. Scott Adzick, Tom Reynolds, Susan Spinner
- CHOP Foundation
- CHQI – Kelly O'Shea, Kristen Nelson, Katie Fox, Jazreel Cheung, Mary Jo Gumbel, Beth Smith
- Developmental Care – Jen Peat, Leah Szeftel, Audrey Wood
- ECMO – Jim Connolly, Susan Williams
- General Pediatric Surgery – Holly Hedrick, Emily Partridge, William Peranteau, Founding Fathers;)
- Maternal Fetal Medicine – Juliana Gebb, Nahla Khalek, Shelly Soni
- Neonatology- Anne Ades, Liz Foglia, Natalie Rintoul, Taylor Wild
- NICU nursing – Lauren Heimall, Emily Rodriguez
- NICU APP – Missy Duran, Erin Kesler, Taylor Van Hoose, Green Team!
- Nutrition – Nicole Dipaoli, Caitlin McCue, Pooja Tolani

- Pharmacy – Anna Bustin, Sarah Gattoline
- Psychology – Joanna Cole, Casey Hoffman, Jane Schreiber
- Pulmonology – Stamatia Alexiou, Sahar Al Baroudi, Anita Bhandari, Howard Panitch
- PHP Program – Lisa Herkert, Melanie Stehouwer
- Radiology – Beverly Coleman, Edward Oliver
- Remote Patient Monitoring – Renee Ebbert, Elizabeth Brown
- Research (Clinical) – Annalise Aarthun, Kiersten Barr, Anna Bostwick, Sabrina Flohr,, Matthew Goldshore,, Sierra Land, Jake Liguori, Leny Mathew, Deepak Nandagopal
- Research (Translational) – Felix De Bie, Alicia Eubanks, Shelley Jain, Abby Larson, Emily Partridge, Nicholas Vinit
- Social Work – CFDT, NICU, PHP Annie Markovits!
- WONDERFUL families who trust us with their care!